TWELFTH ANNUAL REPORT

OF THE

Quebec Society for the Protection of Plants from Insects and Fungous Diseases

1919-1920

SUPPLEMENT TO THE REPORT OF
THE MINISTER OF AGRICULTURE

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1920

To the Honourable J. E. Caron, M.P.P.,

Minister of Agriculture,

Quebec.

Sir:—

I have the honour to present herewith the twelfth Annual Report of the Quebec Society for the Protection of Plants from Insects and Fungous Diseases, containing the proceedings of the winter meeting of the Society, which was held at Macdonald College, Ste. Anne de Bellevue, Que., on the 17th of March, 1920.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

B. T. DICKSON,

Secretary-Treasurer.

Macdonald College, Quebec.

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Rev. Father Superior, La Trappe.
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Canon V. A. Huard, D.Sc., Quebec.
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FINANCIAL STATEMENT FOR 1919-20

Receipts

Brought forward	$142.60
Provincial Govt. cheque	250.00
Interest on deposit	6.93
	$399.53

Disbursements

Expenses of lecturers and members at Annual Meeting	$ 58.70
Expenses of delegates to Ont. Entom. Soc.	14.00
Expenses of delegate to Can. Phytopath. Soc.	25.00
Investigations and Inspection	50.00
Separates	49.75
Express, postage and clerical assistance	24.50
Secretary	50.00
	$271.95
Balance in the Bank, May 10th, 1920	127.58
	$399.53

Auditor:—
E. MELVILLE DUPORTE.

B. T. DICKSON,
Sec.-Treasurer.

W. LOCHHEAD,
President.

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS FROM INSECTS AND FUNGOUS DISEASES

REPORT OF THE WINTER MEETING

The twelfth annual meeting of the Quebec Society for the Protection of Plants was held in the Biology Building, Macdonald College on Wednesday March 17, 1920.

Business Meeting

The business meeting was opened by Prof. Lochhead at 2.00 p.m. Among those present were:—Father Leopold, Vice-President; Dr. J. C. Chapais, Geo. Maheux, Dr. Charron, Professeur Letourneau, A. F. Winn, Professor Lloyd, Professor Dickson, Mr. C. E. Petch, Mr. F. L. Drayton, Mr. C. B. Hutchings, Mr. Buckle, Rev. Dr. Campbell and many others.

The minutes of the last annual meeting as given in the 11th. Annual Report were approved.

The report of the Treasurer was read and accepted. The following officers were elected for the ensuing year:—

President—Professor W. Lochhead, Macdonald College.
Vice-President—Rev. Father Leopold, La Trappe.
Sec.-Treasurer—Prof. B. T. Dickson, Macdonald College.
Curator-Librarian—P. I. Bryce, Macdonald College.
Directors:
Rev. Dr. T. Fyles, Ottawa.
Prof. Letourneau, La Trappe.
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Prof. G. Bouchard, Ste. Anne de la Pocatière.
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Delegates to the Canadian Branch, Phytopathological Society—Rev. Father Leopold or Prof. Letourneau, Prof. Lochhead or Prof. Dickson.

It was resolved that the Society, so far as funds are available, continue to help in aiding investigations concerning entomological and phytopathological questions.

The following resolution was passed by the Society:—

"That this meeting of the Quebec Society for the Protection of Plants place on record its appreciation of the sterling worth, the deep knowledge and high ideals of Dr. C. Gordon Hewitt, and its sorrow at losing by death a member so universally respected, and that a copy of this resolution be forwarded to his widow with the condolences of the Society".

The Secretary was instructed to forward a copy of the above to Mrs. C. G. Hewitt.

It was reported that the work on the Hemiptera or Part IV of the List of the Insects of the Province of Quebec was still is process of preparation and nearing completion.

It was decided that the Summer meeting for 1920 be held in conjunction with that of the Pomological Society at Aylmer, Que.

GENERAL SESSION

The general session of the Twelfth Annual Meeting was opened at 3.15 p.m. in the Biology Building by the President, Prof. Lochhead.

Dr. Harrison, Principal of Macdonald College, extended a cordial welcome to the Society. The addresses and papers are printed in detail in the body of the Report. The evening lecture was given by Prof. F. E. Lloyd, Prof. of Botany, McGill University. Prof. Lloyd is an expert on Rubber, and his illustrated lecture dealing with a recent trip to Java and Sumatra was thoroughly enjoyed by the Society and by the many visitors.

SUMMARY OF ADDRESS OF WELCOME TO THE QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS, MACDONALD COLLEGE, MARCH 17th, 1920, BY Dr. HARRISON.

I am very pleased indeed to be able to welcome our friends from La Trappe, Dr. Chapais, the Entomologists from Ottawa and those interested in the Protection of Plants.

Since your meeting last December here, there has passed away one who had a great interest in this Society and who frequently was present at its meetings, a man who with his training and executive abilities has made a great impression on Entomology throughout Canada. I refer to the death of Dr. C. Gordon Hewitt. I think the majority of you here have known Dr. Hewitt. With his charming personality and his very deep knowledge of

entomology he was an enthusiastic administrator. As a writer of books and of many articles during the course of his somewhat short and brilliant career, he has left an impression on the entomological world and particularly in Canada. His untimely death at the early age of thirty-five is greatly lamented. During the time he had charge of the Entomological Branch, I think the branch has moved forward in leaps and bounds with the organization which he carried on in the various provinces and the work of bringing the importance of entomology to the attention of the public. In the Royal Society of which he was Treasurer, his opinions were always asked for and respected, and although it is hardly my business, I hope that this Society will pass a resolution to send a note of sympathy to his widow.

You will pardon me, I am sure, referring to this in the address of welcome, but I feel that a testimony of appreciation of Dr. Hewitt's work should be recognized.

I do not intend to take up any more of your time. It is rather late in the afternoon and you have an extensive program before you and this is only a one day meeting. I am sure that your meetings will be of great benefit to you. We always have a number of students here interested in Entomology and I am sure that they recognize the opportunity of hearing a number of our friends whom your president has brought out for this meeting.

I wish your Society every success.

THE PRESIDENT'S ADDRESS

THE NATURAL CONTROL OF INSECTS.

W. Lochhead, Macdonald College.

It would almost appear as if Entomologists and Chemists have reached an Aisne line with regard to the control of insects by artificial means. Our spraying mixtures and devices have been developed during the last twenty-five years to such an extent that it is hardly probable that much improvement in these directions will be made. Some changes will be made without doubt in the method of preparation of some of the chemicals used in spraying and some new chemicals, and some improvements will be introduced, but these I surmise, will be of minor importance.

It seems to me that the next great forward step, and the most difficult one, of the economic entomologist must be in the direction of the better utilization of the natural agencies in the control of the injurious insects that cause enormous losses in spite of the wonderful development of the artificial methods in recent years.

To the average layman and others uninitiated into the mysteries of insect life, this method has appealed very strongly, but they fail to realize the great difficulties that stand in the way of a general adoption of such a method. Their imagination has been fired by the successes that attended a few isolated cases,

such as the control of the cottony cushion-scale of California by the introduction of the *Novius cardinalis* lady-bird from Australia, and of the black scale of the olive by the *Scutellista* chalcid from South Africa. They have either forgotten or have not heard of the many partial successes and absolute failures.

The reasons why the natural method of control has not had more cases of success are the extreme complexity of most of the problems, the lack of sufficient knowledge of the factors that operate, and the difficulty of devising measures of control.

The natural agencies of control may be grouped into four:

1.—Climate.
2.—Food supply.
3.—Predatory animals.
4.—Parasitic animals and plants.

Climate: The effects of changing and unnusual conditions of heat and cold, snows and rains, humidity and dryness, and other seasonal changes have long been known to be important factors in regulating the number of insects.

A variable winter is more fatal to most forms of insect life than a continuously severe or a continuously mild winter. When insects go into hibernation they become torpid and are able to resist quite low degrees of cold, but if thaws occur they may become partially active for a short time. With every change of this nature the insect loses vitality and this loss may prevent transformation in the spring. Moreover, the effects of thaws in breaking up larval and pupal cells in the ground are often quite marked.

Sudden changes of temperature of say 30° range within a few hours, which are quite common in our latitude, are very fatal to aphids and many caterpillars during their early stages.

Another feature of the environment of insects is the different degree of humidity demanded by each species or genus. Some insects like the thrips, chinch bug, wheat midge and red spiders are more abundant under dry conditions, while other insects like the plant and Hessian fly develop best under moist conditions.

Observations seem to show that climatic changes are often fatal to those insects that are living on the fringe of their distributional range. Under favorable conditions some insects may migrate northward and even do much damage, but such movements may be termed *incursions*, and are temporary and spasmodic in their character. For example, the San José scale appeared in this locality some years ago but its presence has not been noted since.

Again, the San José scale was for many years an aggressive insect, multiplying rapidly under natural conditions on its numerous food plants, south of the latitude of Quebec. During the severe winter of 1917-18, however, a large percentage of the scales was killed over large areas in New York State and Southern Ontario. So far as can be observed, the only factor that operated more trongly than usual was that of low temperature conditions which lasted for a longer period than usual.

Reparding the action of the climatological factors on insect life a few facts have been ascertained. Bachmetjew, a Bulgarian, determined the effect of varying temperature and humidity on the metabolic activities of several insects. Humidity modifies the effects of temperature; there is an optimum humidity for metabolism, not only for each species but for each stage of each species and for each stage of each individual. Pierce found that the optimum temperature and humidity for the boll weevil are 83° F. and 65° F. respectively.

Ewing found that the development of *Aphis avenae* is prevented at a constant temperature of 90° F., and that the optimum temperature for the production of wingless agamic forms is about 65° F.

Food Supply: This is a factor of considerable importance as most insects tend to multiply rapidly when the supply of food is abundant, and to decrease when the supply is scarce. Without wheat there would be no wheat midge, and the practical elimination of certain forest trees has brought about the disappearance of their insect pests.

Some insects feed upon but a single kind of plant, and if the range of cultivation of this plant be extended the insects will also extend their range. They are apparently hardy enough to withstand different climatic conditions. An excellent illustration of an insect of this kind is the cotton boll weevil. It is apparently a potential enemy as far north as cotton will grow.

Man by clearing forests and making farms where enormous areas of certain crops are grown has made conditions favorable for the development of the insects that feed upon these crops.

Predatory Animals: These are also an important factor that requires more emphasis. First among these are insectivorous birds. In an address to this Society five years ago on "The Web of Life", I stated as follows:—

"Facts which convince even the most sceptical are accumulating regarding the valuable role played by birds in the control of noxious insects. Studies of bird diets prove conclusively that the majority of our common birds feed mainly upon insects. Forbes of Illinois states after a careful study of the contents of the stomachs of birds that about two-thirds of the food of birds consists of insects. Well-informed writers tell us that without birds the earth would be uninhabitable after six years, and yet man in his ignorance is constantly destroying these valuable friends, simply because he finds that they levy an insignificant toll on his fruits and grains. It is possible that we would be better off if certain birds were greatly reduced in numbers, but of this we are not absolutely certain, for the web of life is most complex, and no person knows how far-reaching the results would be.

"Aside from the fact that birds aid very materially in reducing the numbers of insects when they come as scourges, it is very important to remember that birds nip many incipient scourges in the bud. Their mobility and varied character and habits enable them to move rapidly from place to place and thus maintain the

balance of nature which man is always tending to upset. Even in wild nature the balance is never quite complete; at best the equilibrium is unstable.

"It is very interesting that the two great classes of successful fliers should be, in the wide economics of Nature, fitted against one another, wings against wings, freeman against freeman, invertebrate against vertebrate, "little brain" against "big brain", "instinct" against "intelligence". Practically this is the most important conflict of classes that the world knows"—(Thomson).

Among other well-known enemies of insects are toads, skunks and snakes, which are too frequently killed on sight. Mr. Norman Jack, the well-known and well-informed horticulturist of Chateauguay Basin, sent me a letter, received too late for the Annual Meeting, containing the following important suggestions:

"First,—due to the indiscriminate trapping and destruction of foxes, and skunks, in the fruit growing sections, field mice and destructive rodents have become much more plentiful, and the probability is that there will be found many trees girdled, or partly destroyed, when the snow is gone. How little the general public realizes that one of the fruit growers' best friends, by keeping crickets and white grubs in check, is the much despised pole-cat or skunk. The writer hopes that in the near future there will be legislation brought in whereby there will be a closed season, if not a complete protection, for these two orchards friends.

"Second,—a further suggestion which the writer would make is that the laws relating to the protection of bird-life be more widely diseminated and that copies be sent to the authorities of every Agricultural Society in the province, and also to the heads of Municipal Councils of towns, villages, etc. and also if possible to every Justice of the Peace.

"Third,—another item which in the writer's opinion should be considered is that of compulsory care of orchards. One has only to take a trip into Montreal to notice along the way the many neglected apple trees which are a menace to every orchard for many miles. The writer cannot see the moral right whereby a party can neglect a fruit orchard and permit it to infest the country with disease and insect pests, and not try to remedy it, any more than one should be permitted to allow noxious weeds to flourish, without some attempt to control or destroy them, or a cattleman to keep a herd of diseased cattle. The owners should be *compelled* to care for their trees properly, or cut them down and burn them. This no doubt will appear to be drastic measures but it is only by some such drastic action that we can bring the neglectful owners to a realization that in a measure they must be responsible for their neglected trees."

There are, moreover, many predaceous insects that kill large numbers of injurious forms. The lady-birds feed almost entirely on plant-lice and scale insects; the ground-beetles on cut-worms, canker-worms and other caterpillars, and on many injurious grubs in or on the ground; some of the Hemiptera and other insects are also predaceous.

Parasitic Animals and Plants. The part played by parasites is very important. They may be grouped into (a) *parasitic insects,* such as the chalcids,

proctotrypids, ichneumonids, braconids, tachinids and syrphids;

(b) Probably *parasitic protozoa,* such as the diseases of the gypsy caterpillar, the silk-worm, the cabbage-worm, the army-worm and many others;

(c) *Predaceous mites,* such as *Hemisarcoptes;* and

(d) *Parasitic bacteria and fungi,* such as *Coccobacillus* of locusts, *Sporotrichum* of Chinch-bugs, *Sphaerostilbe* of the San José Scale, *Empusa* on flies, crickets and plant lice, *Cordyceps* on white grubs and wireworms, and others, which sometimes cause epidemics.

Another factor in the natural control of injurious insects in forests has been brought out by several observers, and that is that many of these insects do not become epidemic in forests of mixed growth. Tothill tells us that in New Brunswick the Budworm has gained no foothold in areas where the Balsam Fir exists in the primeval condition of mixed growth.

Pteromalus puparum a chalcid parasite of Chrysalids of the Cabbage Caterpillar.

Pimpla Conquisitor ovipositing on a cacoon of the tent-caterpillar. (After Fiske)

A parasitic tachina-fly and its puparum. (After Weed)

Certain farm insects can be most effectively controlled by plowing under infested stubble. This applies especially to the joint worms of wheat, rye and barley and to the Hessian Fly. As these crops are often used as nurse crops for clover the practicability of such a procedure is out of the question, unless a change can be made in the ordinary rotation of crops. It would appear then as if a new system of rotation should be devised by expert agronomists to meet the situation.

We have frequently observed that many of our most conspicuous pests like the Tent caterpillar and the Tussock Caterpillar appear in cycles separated by a period of years. Their disappearance after serious outbreaks is attributed to the work of parasites. But may there not be other factors operating? The matter has never been thoroughly investigated in a scientific manner. Not until all the factors are known and studied can we hope to prevent the periodic outbreaks that do much damage.

Again, in this region, the Cherry-tree Tortrix was more abundant than usual during July of 1919 on wild and choke cherries. An analysis of the situation seems to point to the relative absence of its normal parasites as the main reason for its abundance.

Many other examples might be given but these will suffice to show that the lethal factors in most of the cases are beyond man's control.

Mr. Petch informs me that the Squash bug (*Anasa tristis*) was very abundant about Hemmingford, some fifty miles south of Montreal, yet I have never seen a live specimen on the Island of Montreal, where its food plant is very abundant. I cannot give any satisfactory explanation for its presence in one case and its absence in the other.

It is very apparent that our knowledge of the real nature of the actions of the various natural factors of insect control is wofully deficient.

Mr. J. D. Tothill of the Dominion Entomological Laboratory, Fredericton, N. B., has made some interesting studies of the control factors that operated in 1912-15 in New Brunswick on the Forest Caterpillar (*Malacosoma disstria*) and the Fall Webworm (*Hyphantria sp*), published in the Annual Report of the Entomological Society, Nova Scotia, 1918.

A ground-beetle (**Calosoma sp.**) feeding on cutworm; below, a species of **Carabus.** (After Brehm)

Caterpillars killed by a bacterial disease. (After Washburn)

His observations showed that on the average chicadees and mites destroyed 50 of the 200 eggs in the egg-mass of the Forest Caterpillar, *egg parasites* destroyed 15, starvation killed 67 of the first stage caterpillars, ants killed 51 caterpillars of the 2nd, 3rd, and 4th stages, and *parasites* killed 13 caterpillars and 3 pupae. On the average only 14 adults survived out of 2000 eggs laid the previous season by 10 females. On the supposition that half of the survivors were females; the reduction would be only 30 percent in spite of the very heavy mortality.

In 1914, there was no starvation and no reduction by ants, consequently a great increase in caterpillars occurred, and the egg masses were so numerous that a scourge of caterpillars in 1915 was looked for, but a light frost occurred in 1915 during the first stage of the young caterpillars, with the result that practically all of them were destroyed. In 1916, they were so rare that they could not be found.

Mr. Tothill's studies of the Fall Webworm for six years (1912-1917) show that about 10 percent of the egg-mass of 300 do not hatch. In 1912, the parasites

were mainly responsible for the reduction in numbers, but for the last five years the webworms became scarce. The parasites died out and the birds became the most important factor of control. Mr. Tothill pointed out that just when the webworms were at the point of extinction a southeast wind brought in a flight of webworm moths from Nova Scotia, with the result that these have greatly increased since their parasites are few in number.

He points out also that the 1917-1918 outbreak of Fall Webworms in Nova Scotia was due to the scarcity of two parasites *Varichaeta* and *Limnerium,* which were abundant in 1912 in New Brunswick, and that if measures had been taken in 1912 to introduce these parasites into Nova Scotia, the outbreak could have been prevented.

Mr. Tothill also cites the case of a heavy isolated outbreak of Forest Caterpillars at Red Deer, Alberta, in 1917-18. An examination failed to find a single parasite, and he believes that if precautions had been taken four years before to introduce its two chief parasites, *Limnerium* and *Blepharipeza,* from the Atlantic board or the Provinces where they were abundant, the outbreak could probably have been prevented.

Australian ladybird-beetle **(Novius cardinalis)**, the enemy of the cottony-cushion scale. (Natural size)
a—lady bird larvae feeding on adult female and egg sac; b—pupa; c—adult ladybird; d—orange twig, showing scales and ladybirds. (After Marlatt, United States Dept. of Agric.)

Sphinx caterpillar with cocoons of braconid parasites.

Early attempts to employ natural methods of control.

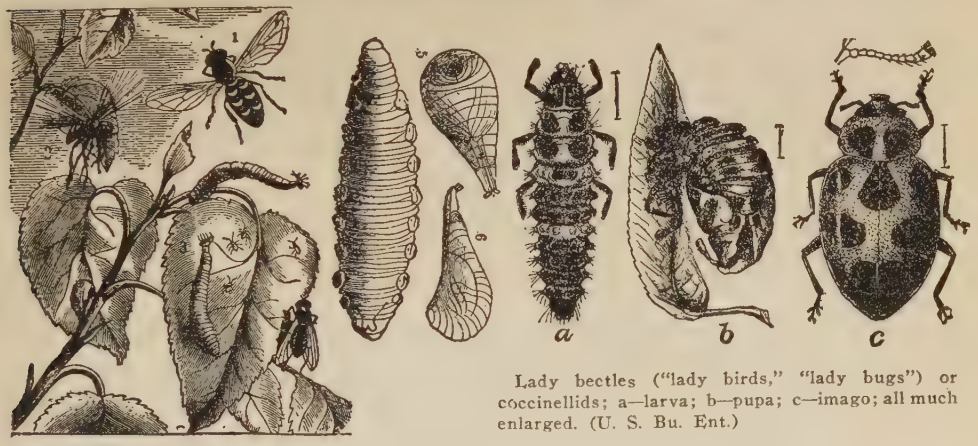
Silvestri tells us that the first person to employ successfully parasitic and predaceous insects was Boisgiraud of Poictiers, France. About 1840, he rid the poplars along a promenade in a suburb of his town of the Gypsy moth by introducing the carabid *Calosoma sycophanta,* and he destroyed the forficulids in his garden by using a rove beetle *Staphylinus oleus.*

Boisgiraud's successes prompted a Milan Society in 1843 to offer a gold medal to the person who had in the meantime carried out successfully experiments on the artificial breeding of carnivorous insects which may be utilized to advantage for the destruction of other insects injurious to agriculture. Antonio Villa responded with a report dealing with successful experiments he had carried

on at Disio near Milan. Villà employed climbing carabids to destroy all the forms feeding on the plants, staphylinus to destroy insects feeding in flowers, and ground carabids to hunt out all insects that feed at the surface of the ground.

From 1850-1873, Rondani, an Italian, made the most valuable contributions to the study of parasitology. He was of the opinion, however, that parasites were far more important than birds as control factors. He said: "The policing of the fields cannot be entrusted to birds because they are unreliable and kill the guilty with the innocent; they are robbers as well as guardians of the field products, and therefore do not yield the most, and sometimes any calculable advantage, if not, even more farm than good in the very things which were sought to be saved by their means".

Perris and Decaux of France in the seventies and eighties advocated strongly the use of parasites, and Berlese and Del Guercio of Italy later recognized and emphasized the value of entomophagous insects rather than insectivorous birds.



Lady beetles ("lady birds," "lady bugs") or coccinellids; a—larva; b—pupa; c—imago; all much enlarged. (U. S. Bu. Ent.)

Syrphus flies; 1 and 2, adults; 3, larvae eating plant lice; lower figure contracted larva; 5 and 6, view of larva, enlarged, and pupa.

In this connection it is interesting to note Silvestri's own opinion. He says : "I, for my part, believe that the usefulness and the harm of insectivorous birds balance each other and that more frequently the former may be superior to the latter, considering things only from the viewpoint of immediate agricultural interest."

The utilization of parasites for the control of injurious insects has been attempted on the greatest scale in New England in connection with the suppression of the Gypsy and Brown Tail Caterpillars. These pests came to America without their parasites and as the native parasites did not appear to relish them the new arrivals multiplied exceedingly and became a serious menace to shade and forest trees.

Efforts were then made to introduce its foreign parasites, but the difficulties of the task soon became apparent. Besides the labor of gathering sufficient numbers and of transporting them without loss, there was much trouble in sorting

them out and breeding them in large numbers for liberation in infested districts. In addition the "secondary" parasites which were also imported with the "primary" had to be collected and destroyed.

Notwithstanding all these efforts, the authorities in charge of the work are of the opinion that the present improvement is due to at least three other factors, viz. "the perfection and standardization of the methods for artificial repression, the death of a large proportion of the more susceptible trees or their removal from the infested woodlands, and the development of the "wilt disease". Of course, there is the possibility that the imported parasites will in time become sufficiently numerous to hold the pests under control as they do in Europe. This result will be obtained when 85 or 90 percent of the eggs and caterpillars are killed, as the actual rate of increase of the Gypsy moth is from 6 to 10 fold.

It will be evident, therefore, that successful control of injurious insects by parasitic and predaceous forms depends upon several favorable factors and sets of conditions. These have been well summarized by H. S. Smith (Journ. Econ. Ent. Aug. 1919) as follows:—

1.—The reproductive capacity of available entomophagous insects must be much higher than that of the host. This proposition is self-evident, and needs no amplification.

2.—A complete sequence of parasites affecting the egg, larva and pupa of the pest. The importance of this factor was fully shown in the campaign against the Gypsy moth.

3.—The entomophagous forms must be capable of being reared or obtained in sufficient quantities to overcome the pest in the field. This factor is one of the most difficult to bring into operation. Lady-birds are readily reared and collected.

4.—The cost of producing natural enemies must remain well within the bounds of profitable crop production.

5.—Secondary parasites in the local fauna should limit as little as possible, much less entirely prevent, the action of the primary parasites. This factor is also one that is most difficult to control.

6.—Agricultural practices such as spraying and fumigation which affect adversely the breeding of natural enemies should be prevented. It is probable that the extermination of the imported Chinese Lady-bird in southern orchards was due mainly to spraying operations with lime sulphur carried on as a practice.

7.—The relative ability of the pest and its enemies to spread is an important factor. If both be good fliers the power of spreading is increased but the likelihood of extermination of the pest is lessened.

The citrus mealy-bug has been controlled in Southern California by the lady-bird *Cryptolaenus montrouzieri* which was reared in large numbers at the State Insectary and collected in orchards where they had become abundant late in the season. In this instance, as in that of the cottony-cushion scale, the lady-bird is an active insect while the scale insect is fixed to the plant. Moreover, the lady-bird has more generations that the scale insect and is practically free from parasites.

The utilization of fungous and protozoan diseases in insect control. (*)

Many experiments have been conducted within the last thirty years with the object of controlling injurious insects through the artificial production of epidemics of fungous diseases. As in the case of parasitism unexpected difficulties have appeared under field conditions. It was soon discovered that "fungi are very dependent upon external conditions, and in many cases the apparent absence of a particular fungus in a locality is usually an index of conditions unfavorable for its development and an artificial introduction will be useless" (Glaser).

Out of the large number of experiments that have been carried out, I shall briefly refer to a few of the most outstanding ones. Franz Tangl in 1892 used spore emulsions of *Botrytis bassiana* against the caterpillars of the nun moth of Central Europe. While the experiments were eminently successful in the laboratory where all the infected caterpillars died of "muscardine", those carried on outdoors gave negative results. Tubeuf also obtained like results with *Cordyceps militaris*.

Many of us perhaps are familiar with the work of Snow and Forbes in connection with the artificial use of *Sporotrichum globuliferum* against chinch bugs. Later Billings and Glenn also carried on experiments with the same fungus. Their results are summarized as follows:—

1.—"In fields where the natural presence of the fungus is plainly evident, its effect on the bugs cannot be accelerated to any appreciable degree by the artificial introduction of spores.
2.—"In fields where the fungus is not in evidence spores introduced artificially have no measurable effect.
3.—"Apparent absence of the fungus among chinch bugs in a field is evidence of unfavorable conditions rather than lack of fungous spores.
4.—"Laboratory experiments can be made to prove that artificial infection accomplishes results upon bugs confined in cramped quarters and without food, but in the field, where fresh and usually drier air prevails and food is abundant, an entirely different situation is presented."

In 1912 Morrill and Back experimented with the artificial use of the white fly fungi, *Aegerita webberi, Aschersonia aleyrodis* and *A. flavocinta*. They summarized their conclusions in these words:

1.—"The fungus parasites thrive only under suitable weather conditions during a period of about three months each year; generally speaking the summer months in the case of the two Aschersonias and the fall months in the case of the brown fungus.
2.—"Under natural conditions, without artificial assistance in spreading, the fungi have ordinarily, in favored localities, controlled the white fly to the extent of about one-third of a complete remedy through a series of years.

(*)—European botanists, such as DeBary and Tulasne, about the middle of the last century called attention to the importance of white muscardine (*Isaria densa* Link.) as a check on many insects. Metchnikoff, and Krassilstscik cultivated the green muscardine (*Metarhizium anisopliae* Sorokin) for the control of *Anisoplia* and the beet weevil (*Cleonus punctiventris*).

Efforts have also been made to check the white grub in Europe by means of *Cordyecps melolonthae* Tul., *Isaria densa*, and *Botrytis tenella* Sacc.

3.—"The infections secured by artificial means of introducing fungi, while successful in introducing the fungi, have thus far proved of little or no avail in increasing their efficacy after they have once become generally established in a grove.

4.—"Experiments by the authors, and by citrus growers in cooperation with the authors, involving the treatment of thousands of trees with suitable "checks" or "controls" have shown that when fungus (red or yellow *Aschersonia*) even in small quantities is present in a grove, there is no certainty that from three to six applications of fungus spores in water solution will result in an increased abundance of the infection on the treated blocks of trees by the end of the season. In some of the most important and carefully planned and executed experiments, the fungus has increased more rapidly in sections of the groves which were not sprayed with spore solutions than in the experimental blocks".

The Brown-tail caterpillar is attacked by the fungus *Entomophthora aulicae,* and an attempt was made by Speare and Colley in 1912 to use it in the control of the pest. They state that considerable success has attended their efforts, not that the fungus is a "cure-all" but it is a powerful check. Under proper conditions of introduction from 63 to 100 percent of the caterpillars can be destroyed.

Reference has already been made to the "Wilt disease" of Gypsy-moth caterpillars as a factor in the control of these pests in New England. It made its appearance about 1900 and is now distributed over the territory infested with the Gypsy-moth, according to Glaser. It is an infectious disease but epidemics occur only in localities infested heavily with the Gypsy-moth. Infected caterpillars become flaccid and later their tissues disintegrate completely, due to the fermentative and toxic nature of the virus. The brown liquid of a dead caterpillar shows under the high power of the microscope large numbers of polyhedral bodies of various sizes, but the exact nature of the causal organism has not been determined. The virus is filterable with difficulty.

The success of wilt infection experiments is absolutely dependent upon attention to seemingly insignificant details, but this much is known that infection takes place through the mouth by means of the food.

It is probable that further studies of the disease will evolve some practical method of using the virus for the destruction of larger numbers of the caterpillars. Already, however, it has been ascertained that climatic conditions appear to bear an important relation to wilt in the field, and that temperature has an important relation to the period of incubation of wilt.

The Complexity of the Problem.

The problem of the control of insects by the natural agencies I have just mentioned is in most cases a very complex one, on account of the large number of factors operating, many being for the present beyond man's control. Under one set of conditions a certain control is observed but under another set of con-

ditions where the same factors, it may be, are operating but under relatively different intensities, the result is different.

While progress in the control of insects by natural means may appear very slow, and the results meagre, considering all the efforts that have been made, yet when we look back over the last forty years and scan the records of achievement, whether they be successes oar failures, one fact looms up distinctly, that much advance has been made towards a better understanding of the operation and the inter-relations of the factors. With this valuable knowledge we may confidently press forward to other achievements which will eventually give us the clue to the control of injurious insects by natural means.

REPORT OF THE DELEGATE TO THE ENTOMOLOGICAL SOCIETY OF ONTARIO

By Firmin Letourneau, Oka.

The "Quebec Society for the Protection of Plants" had delegated me and I had the honor to take part in the deliberations of the Fifty-Sixth Annual Meeting of the "Entomological Society" of Ontario, held at Ottawa, Thursday and Friday, November 6th and 7th, 1919.

The assembly was large and most of the Canadian entomologists, as well as several from the United States, formed the deliberative part of it.

The Addresses given were generally short, but of the greatest importance, as usual.

At the first sitting, the President of the Society, Mr. L. Caesar, professor, Ontario Agricultural College, Guelph, and Mr. W. A. Ross, Dominion Entomological Laboratory, Vineland Station, Ontario, spoke of the most pernicious insects of last year: to wit: the Codlin Moth, the Cigar-case bearer, the Blister Mite, the San-Jose-scale, the Pear-slug, the Tussock-Moth, the Plum-weevil and the Potato-leaf-hopper. The particulars given in connection with each of them were most interesting.

Mr. R. C. Treherne made a short report of his work at the Dominion Entomological Laboratory, Vernon, B. C., and Mr. G. C. Spencer, Guelph, a soldier of the Great War, closed the first session by giving the meeting an idea of the experimental work he was conducting with *Chloropicrin* for the control of insects injurious to grain.

Dr. C. G. Hewitt, the great entomologist whose voice is now silent for ever and who is regretted by the whole scientifical world, gave the last address of the second session of the 6th. He spoke of the new insect *Ephydra hians,* which had made its first appearance in the Canadian West.

At this same session, Mr. George A. Moore, Montreal, gave a 15 minutes address on our common Cercopids; Mr. W. A. Ross, gave new particulars on the control of the Pear Psylla; Rev. Fr. Leopold, of La Trappe, made a short but substantial report of his experiences this year in dusting and spraying; Dr. S. Hadwen, Ottawa, noted his recent observations on Eastern Ticks, prejudicial to animals; Mr. Tothill, Fredericton, gave his method of controlling insects by natural agents and Dr. J. M. Swaine, Ottawa, spoke of the Spruce Budworm, the most injurious insect to Spruce and Balsam in Quebec.

Dr. Swaine said that this insect had already destroyed a large part of our Spruce and Balsam forests, specially in the Gatineau, Saint-Maurice and Rimouski regions. Up-to-now, the Gaspesian forests alone have remained free from its ravage. (The 11th report of the Society, page 45).

The night session of this first day of the meeting was presided over by Dr. Grisdale, deputy-minister of Agriculture.

Mr. Marlatt, Chairman of the Federal Horticultural Board of Washington, made such a practical report of the different methods and means used in the United States to prevent the entrance of new insects into America, that I am induced to give here a summary of his remarks:

"A whole host of pests have come into the states during the last twenty years and have become naturalized, and now we have to combat them as best we can. We have lately concluded our list of foreign insects that have come into this country or are likely to come, and the Plant Pathologists are doing the same thing for their line of work. It is the unknown things that are the evils. These things we never suspected in the past until we began to suffer from them, and now, through one cause or another, we loose nearly two billion dollars per year, according to the current prices of our crops. As early as 1907 we got a bill before Congress to control the importation of these pests, the chief of which at that time was the San José Scale, but after hanging fire some years the bill failed to pass. Congress objects strenuously to legislation of this kind as being centralization of legislation. The nursery men also object.

Then came the Brown-tail and the Gypsy Moth from Europe, causing immense damage and we had no legislation to control it. I had a hard fight for four years to get the bill through, with many rebuffs from individual Congressmen: men who were the chief supporters of the bill at last, the very men who finally got the act through. This act gives us power over all plants or plant products coming in from foreign countries and over inter-state movements that may introduce insect pests. Its scope is very broad. The men are appointed from the Bureaus of Plant Industry, Forestry and Entomology and the act is promulgated by the Secretary of Agriculture.

"The Act requires the co-operation of the whole world: India, China, Europe and Canada and over 30 foreign countries have now appointed various experts. The head-quarters of our service is Washington with inspectors at all points of Entry and men in every state.....

"Notwithstanding all this, insects come in from Europe so we promulgated the "Plant Quarantine Act 37", the law which caused all the trouble in 1918 lest we exclude every plant from abroad. It has developed on this side the nursery stock industry to a large extent and we do not have to go outside for anything but absolutely necessary stock which we allow to enter so long as it does so through the agency of the Department of Agriculture and its safe-guard. In this way we are becoming independent of other countries and we are not risking the importation of foreign insect pests.

Friday, the 7th, Mr. W. Lochhead, Macdonald College, gave an interesting address to the meeting on "Hopkins' Bioclimatic Law". Mr. Winn, Montreal, whose address was titled "On the Wings of the Wind", delivered a splendid address on butterflies, then came Mr. Norman Criddle, Dominion Entomological Laboratory, Treesbank, Man., with his favorite canvas: "Locusts in Manitoba with special reference to the ourbreak in 1919."

Mr. Brittain, Truro, gave a very interesting address: "Symposium on the Cabbage Root Maggot and its Control in 1919." (Refer to the 9th report of the Society, page 31). The insect (*Phorbia brassicae*) lays its eggs near the stem of the cabbage, on the soil. Worms go down into the soil and attack the roots of the plant which wilts and often dies. Mr. Brittain said that, as a means of control, the tarred paper, placed about the stem, close to the soil gave good results. But, by his own experiments, he contends, and this is affirmed by many of the entomologists present, that to kill the insect it is quite sufficient to sow along the row of cabbages, some clay mixed with creosote. This mixture would not cost more than 5 cents per 100 pounds.

Many other addresses were also given: Mr. F. J. A. Morris: "Life-History of a Hobby-Horse"; Mr. E. H. Strickland, Entomological Branch, Ottawa: "Present Status of Pests of Canadian Flour Mills"; Mr. Hudson, Dominion Entomological Laboratory, Strathroy, Ont.; "Our common June Beetles"; Mr. Downes, Victoria, B. C.; "Control of the Strawberry Root Weevil"; Mr. Ross, Vineland Station, Ont.: "The Strawberry Weevil"; Mr. Arthur Gibson, Ottawa: "Borers in Corn and other Field and Garden Plants which have been or may be mistaken for the European Corn Borer."

REPORT OF THE DELEGATE TO THE CANADIAN BRANCH OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY.

Professor B. T. Dickson.

Mr. President and members:—

I have the honour, as your representative at the annual meeting of the above Society, to present herewith a report of the proceedings.

The meetings were held at Guelph, Ont., in the Biological Building of the Ontario Agricultural College, on Dec. 11 and 12, 1919.

There were present about forty members among whom may be mentioned:— Dr. A. H. R. Buller of Manitoba Univ., Prof. W. P. Fraser of Saskatoon and late of Macdonald College, Dr. W. H. Rankin of St. Catherines, Dr. J. H. Faull of Toronto Univ., P. A. Murphy of Charlottetown, P.E.I., and W. L. Drayton of the Central Experimental Farm, Ottawa.

The guest of the Society was Dr. E. C. Stakman, of Minnesota, a practical authority on Rusts of cereals.

The meeting opened with the Presidential address by Prof. J. E. Howitt of the O. A. C. He dealt concisely in his remarks with the following points:— The immediate and pressing need for some arrangement whereby contributions to our knowledge of Plant Pathology may be published in Canada; the education of Plant Pathologists both as to their technical studies and as to their relations with the agricultural community; the value of standardizing the requirements in the training of Plant Pathologists; the unification of recommendations to farmers; and finally the need for a plant disease survey of the Dominion.

The President's address opened up avenues for discussion of which advantage was taken, especially at the evening session.

This evening meeting took the form of a Smoker and was very much enjoyed by all present. Dr. Stakman dealt with the "Rust Problem". He is a forceful speaker, enthusiastic in his work, and consequently he held his audience spellbound for an hour. It is impossible, unfortunately, to do more than state the salient fact of his address in this report. He showed very clearly that, whilst urediniospores of *Puccinia grammis tritici* may live over winter and then give rise to the commencement of an outbreak of Black Stem Rust of wheat, the barberry was a still potent agent in this respect. He strongly advocated the thorough extermination of the common barberry (Berberis vulgaris L.) and its replacement by the Japanese barberry (Berberis Thunbergii) or some other equally ornamental but harmless shrub. He pointed out that a hybrid between the common barberry and the Japanese barberry was also an alternate host, and that this hybrid looked remarkably like the true Japanese barberry.

Dr. Stakman also spoke on Friday afternoon, Dec. 12th., when he discussed some of his work with Biologic species in the cereal rusts, illustrating his remarks with lantern slides.

Following his evening address came a discussion of the educational requirements of Plant Pathologists. Dr. J. H. Faull opened the discussion. After an animated consideration of the various subjects which came within scope of the work of a practising Plant Pathologist it was decided to appoint a committee to draw up recommendations, the committee comprising: Dr. A. H. R. Ruller, Dr. J. H. Faull and Prof. J. E. Howitt. A report will probably be forthcoming at the next annual meeting. It was also resolved that the above committee be authorized to wait upon the Minister of Agriculture to urge the early appointment of a Dominion Botanist who can command the confidence of Plant Pathologists and Agriculturalists generally.

The papers given during the sessions covered a wide field and it is impossible to give a detailed account, but an attempt will be made to give the substance of each.

"Health and Disease in Plants", by F. L. Drayton.

In this paper it was urged that greater attention be paid to physiological studies and to the normal and abnormal structure of plants in order that an intelligent attempt may be made to understand the nature of diseases in plants. In this all those who have the science of Phytopathology at heart will agree with him for that science cannot be allowed to desiccate in a mycological herbarium.

"Decay in the Timber of Pulp and Paper Mill Roofs", by R. J. Blair.

The moist conditions obtaining in pulp and paper mills permit of the rapid development of wood rotting fungi so that roofs require to be renewed every six or eight years. The chief fungi concerned are:—*Lentodium tigrinum, Lenzites trabeum,* and *Poria xantha.*

The remedy for such timber decay involves the following four points:—use of timber which is resistant to decay; ventilation to remove excess moisture; liberal dry air heating; and the placing of a layer for heat insulation on the upper side of the roof planks.

"Butt Rots of the Balsam Fir in Quebec Province", by W. H. Rankin.

Dr. Rankin explained the dying of Balsam Fir over extensive areas as being due to the Spruce budworm and to Fomes pinicola, the latter giving rise to a butt rot. In most cases he found that the taproot was first infected and that from the taproot the disease spread to the butt.

"Leaf Blight of the Pine", by J. H. Faull.

A deathrate as high as 5% was found in some areas of northern Ontario. The symptoms are very similar to winter browning, and in fact many lumbermen speak of it as frost injury. No inoculation experiments were successful. Young trees in most cases recover.

"Pseudorhiza of Certain Saprophytic and Parasitic Agaricineae", by A. H. R. Buller.

Dr. Buller showed that typical pseudorhizae were not uncommon among the Agaricineae and illustrated his paper with lantern slides from photographs. These were of pseudorhiza carefully excavated and photographed in situ.

"Some comparative observations upon the shape of Basidia and Method of Spore Discharge in the Uredineae and Hymenomycetes", by A. H. R. Buller.

In this very interesting paper it was shown that the shape of the basidium and of the promycelium was always such as to allow of the rapid and unhindered discharge of the spores when mature. Dr. Buller also showed that, contrary to the statements of certain German scientists, there was always formed just prior to spore discharge a minute drop of liquid at the "hilum" of the spore. When the basidiospore was discharged this drop was carried by the spore. The time occupied in the formation of the drop was of such short duration that this fact accounted for the lack of general observation of its formation.

"Witches Broom of the Canada Balsam and the alternate hosts of the causal organism", by R. E. Stone.

Dr. Stone gave a short account of his infection experiments with Aecidium elatinum Alb. et Schw. to show its relation to *Melampsorella cerastii Pers.* He had been able to produce infections on *Stellaria media* by acciospores from *Abies balsama,* and also on *Cerastium vulgatum* from the same source.

Arthur has connected *Aecidium elatinum* and *Abies lasiocarpa* with *Melampsorella cerastii* on *Cerastium oreophilum.*

Wier connected Aecidium on *Abies lasiocarpa* with *Cerastium oreophilum* and *Stellaria borealis.* The same aecidium is reported on *Abies grandis* but no culture work has been done.

There is an aecidium on the western spruces, *Picea angelmanii* and *Picea paryanna* and on Norway spruce in the west. Aecidium is known as *Aecidium coloradense* and Weir has connected this Aecidium on *Picea engelmanii* with the Melampsorella on *Stellaria borealis* and *Stellaria longifolia,* so that it seems possible that this aecidium on spruce is the same as the aecidium on the balsalms and firs, but more work on this should be done.

"New or little known diseases of the potato which cause the running out of seed", by P. A. Murphy.

Mr. Murphy described pathological conditions of potatoes which were denominated "Streak", "Crinkle", and "Leaf drop", these names clearly indicating the symptoms in each case.

"A Smut of Western Rye Grass", by Professor W. P. Fraser.

A smut of Western Rye Grass is prevalent in the prairie provinces of Canada, sometimes the percentage of infection being as high as 60% or more. This smut attacks the spikelets and sometimes the glumes. The smut is close to *Ustilago bromivora,* but is regarded as distinct by Dr. Clinton and has been named *Ustilago Agropyri Clint.*

Field experiments and laboratory studies have shown that this smut belongs to the seedling infection group. The smut is carried over the winter by spores on the seed. The ordinary seed treatment by a solution of formalin gave complete control, and no injury of the seed was evident.

"Some Observations Made in Inspecting for Leaf Roll and Mosaic", by Prof. J. E. Howitt.

During the past two seasons (1918-1919) an effort has been made to improve the potato crop in Southern Ontario. This involved disease surveys of the potato growing sections of Southern and Northern Ontario; a system of inspection and certification for disease in seed potatoes, and the testing for disease and yields of potato seed grown in Northern Ontario, Southern Ontario and New Brunswick.

The seed from these sources was grown side by side on eighty different plots in forty counties of the Province during the past two years, and records kept of the percentage of serious disease and yield per acre. The results obtained and the observations made during the carrying on of this work may be summarized as follows:—

Seed potatoes grown in Northern Ontario are freer from Leaf Roll and Mosaic and give larger yields per acre than those grown in Southern Ontario and New Brunswick. Leaf Roll is especially prevalent and severe in the Southern and South Western portions of Southern Ontario. In most sections of Southern Ontario, Leaf Roll appears to spread and cause more loss each year that the same seed is used. In Northern Ontario, Leaf Roll does not seem to spread nor to increase appreciably in amount from year to year in the same stock. Under climatic conditions such as we have in Southern Ontario, Mosaic appears to be suppressed some years. That is, when seed from Mosaic stock is planted in some seasons, no Mosaic is observed in the resulting crop. In Northern there appears to be no such suppression of Mosaic, it apparently appears in infected stock year after year. Mosaic evidently spreads in the one year from diseased to healthy plants and one of the chief agents in its transmission appears to be the Leaf Hopper (Empoasca mali Le Baron.)

"A new disease of the poplar", by A. W. McCallum.

A disease, well-known in Europe, caused by *Napicladium Tremulae* (*Frank*) Sacc. is recorded for the first time on this continent. It is characterized by the death of young shoots and the shrivelling of the leaves. Only the conidial stage has been observed as yet, this being common on *Populus tremuloides* and *P. grandidentata* in Ontario and Quebec.

"Some data on peach yellows and little peach in Ontario", by L. Caesar.

The first appearance of yellows in Ontario was about the year 1874 and of little peach about 1895. The outbreak reached its culmination in 1911 when there was a loss of approximately $1,000,000. Experiments to prove transmissibility of the disease gave varying results but orchard inspection and past experience tend to show that the removal of diseased trees is by far the safest plan, especially as a safeguard against an epiphytotic.

At the close of the session Dr. Rankin and Prof. Fraser were named a committee to consider the taking of a plant disease survey of the Dominion.

The following officers were elected for 1920:

President.....Dr. A. H. R. Buller
Vice-President.....Dr. J. H. Faull
Sec.-Treas.....Dr. R. E. Stone
Councillor.....Prof. J. E. Howitt
Councillor.....F. L. Drayton

A BRIEF STUDY OF A FEW CECIDOMYIIDAE

By Dr. J. C. Chapais, St. Denis (en-bas).

Though I am not an entomologist by vocation, it happens, now and then, that I make an excursion in the field of entomology to find out those insects that are either noxious or useful in agriculture so as to establish the amount of their noxiousness or of their usefulness and to learn how to destroy or protect them.

This is the reason why I wish, to-day, to make this brief study concerning a few insects of two or three genera of the nematocerous Diptera (insects with flamentous antennae) or small two-winged flies, typical of the family Cecidomyiidae.

The family comprises a vast number of minute slendered-bodied midges, which are of special interest on account of their mode of life, the peculiar structure exhibited in the larvae and the economic importance attached to several species. In most cases, the female lays her eggs in the stems, leaves or buds of various plants, producing gall-like excrescences of various forms inhabited by the larvae.

The Hessian fly, **Mayetiola destructor** (Say). Healthy wheat stock at left and infested stock at right; a—larva; c—puparium or "flaxseed"; d—pupa exposed; e—adult female laying eggs; f—female; g—male; h—puparia or "flaxseed" in natural position between leaves and stalk; i—parasite (**Merisus destructor**). (Slightly enlarged, excepting c, whis is smallar than natural). (After Riley, Burgess and Forbes)

Some species, however, do not produce galls, and among them are the Hessian fly, *Cecidomyia destructor* or *Mayetiola destructor,* Say (*Cecidomie destructrice*) ; the *Dasyneura leguminicola* Lint, Clover flower-midge, Clover seed-midge (*le moucheron du trèfle*) and the *Dasyneura rhodophaga* Coq, Rose-midge (*Moucheron de la rose*). These last three mentioned insects, and another one which produces galls on the fruit of the Choke-Cherry tree (*Cerasus Virginiana*) and called *Cecidomyia* or *Contarinia Virginiana* will be the subject of the few notes I intend to communicate to you in the present study.

I do not pretend to impart new knowledge concerning the Cecidomyiidae in the following notes. All I mean to do is to extract from a few bulletins, written in English, the substance of what they contain about the four insects above mentioned and to communicate it in the French version of our report to my French

countrymen who have not the advantage of reading it in English, not absolutely because they do not, some of them, know that language, but because they have no occasion to read the English bulletins.

I shall take these cecidomyiids in the order they occupy in my mind, according to the dates of our acquaintance with them. The first, the Hessian fly, I have known for forty years. This insect is so well known in Quebec that I am not going to speak of it at length, nor even describe it as it is found in the two Canadian works which were written about it as early as in 1856. I mean the essays by Hind and Provancher under the pseudonym of Dupont. I purpose here giving a summary of the control measures to be taken against this terrible foe of our wheat crops. These measures, after Criddle, are the following:

(1) Plowing all infested stubble land between August 15th and the middle of May of the following season, plowing to be not less than five inches deep; (2) burn all stubble and straw piles between the dates mentioned above; (3) carefully gather up all screenings and use the same as feed, or destroy them before May 15th; (4) infested land unable to be treated by plowing or burning at the proper time should be disked or cultivated as soon as possible and plowed June 20th; (5) sowing strips of grain about 20 feet wide between infested stubble and newly planted grain to attract flies may be resorted to on occasions of severe outbreak (The strips should be planted early and plowed down about the middle of June); (6) prepare a good seed bed and use the best of seed. Vigorous plants will be more able to resist attack; weak ones are easily killed out.

The second cecidomyiid with which I came into contact was *Cecidomyia Virginiensis* or *Contarinia Virginiana* Felt. In the Summer of 1915, I saw in a Choke-Cherry tree an abnormal agglomeration of ill-shapen fruit in many of the ordinary clusters. Looking attentively at them, I thought that they resembled the plum pockets found sometimes in plum trees subject to the invasion of the *Exoascus*. They were of course smaller, being on an average twice the size of an ordinary Choke-Cherry. Upon examination, I found them filled with a swarm of very small red larvae. After having sent the specimens of these galls and larvae, first to Dr. C. Gordon Hewitt, Dominion Entomologist, Ottawa, I learned that the galls were due to the fact that the Choke-Cherry fruit had been punctured and filled with eggs of the Cecidomyia Virginiensis, and later I received from Dr. E. P. Felt, New York State entomologist, of Albany, the best American authority on Cecidomyiidae, a letter revealing quite a host of insects inhabiting those galls, such as: *Arthrocnodax spiphila, Contarinia Virginiensis* (Felt), *Cecidomyia Virginiensis, Itonida Canadensis* (Felt), *Parallelodiplosis acernea* (Felt), *Lestodiplosis, Dasyneura leguminicola*. This second Cecidomyiid may not be very noxious, especially if we compare them with the damage caused by the *Cecidomyia destructor,* previously mentioned, and the next one that we are going to submit to our investigations, the Clover-flower midge, *Dasyneura leguminicola*.

This Dasyneura was the third cecidomyiid with which I became acquainted, in 1918, in a clover-seeded orchard of Saint-Remi de Napierville. This is, as in-

dicated by its name "Dasyneura leguminicola", a cecidomyiid causing havoc of all clover crops. I first saw it in Napierville, in July, and it had invaded the whole area of an orchard of 2 x 4 arpents. Not less than three fourths of the crop was destroyed by these tiny, bright-red insects invisible in the well sheltered depths of their leguminous abode.

I know of but one means of fighting this minute enemy of our clover crops; it is that of mowing down the first crop of clover as soon as it is in bloom. The first generation of this foe, which would otherwise invade the second crop, will thus be destroyed and will ensure a clean second growth.

The fourth cecidomyiid is known to me only through engravings, and we consider it is a lucky thing for our Quebec rose growers that we do not know it otherwise yet, for, it is said to be one of the most noxious insects to be met by flower growers. It is called *Dasyneura rhodophaga* or the rose midge (*Le moucheron de la rose*). The first article that I read concerning this rose midge occurs on page 33 of the report of Dr. Hewitt, Dominion Entomologist, for the year 1914-15. It reads as follows:

"Rose Midge (*Dasyneura rhodophaga* Coq).In July, specimens of rose "shoots (variety Mrs. J. Laing, H. P.) were received from London, Ont., the "tips being "destroyed by a Cecidomyiid larva. About three hundred rose-bushes "had been affected in this manner. Specimens were submitted to Dr. E. P. Felt, "who reported that it was probably the Rose Midge (*Dasyneura rhodophaga* "Coq), with which suggestion the observations we made agreed. This appears to "be the first record of this pest, which is considered to be the worst pest with "which the rose grower has to deal. An investigation of the insect is being under-"taken".

The forty-seventh report of the Entomological Society of Ontario for 1916 tells of another outbreak of that insect in Canada in the green house of Messrs Miller & Sons, of Toronto. It gives also the life-history of that insect.

It has been observed for the first time in America in the green house roses of the State of New-Jersey.

"The perfect insect, or midge, is two-winged and is closely related to the "Chrysanthemum Midge. The female deposits its yellowish eggs, which are so "small as to be hardly visible to the naked eye, beneath the sepals of the flower "buds or between the folded leaves of the leaves buds. The egg period is recorded "as being only two days. When the young, whitish maggots hatch they at once "begin to destroy the terminal leaves and the blossom buds, and in from about "five to seven days they become mature and then leave the plant, dropping to the "soil where they change to the pupal state. Webster has observed as many as "twenty five larvae in a single blossom bud. David states that in summer the fly "emerges about six days after pupation occurs. In green houses in Chicago, the "insect has been present from June until October or November in such numbers "as to make is impossible to secure a single crop of flowers. During the colder "winter months, it is assumed that the insect is present in the pupal state in the "green house soil."

This report gives also three good drawings of the egg, larva and puparium of the rose midge and one of a rose bud destroyed by the larvae of the rose midge.

I hope these few notes on four of the Cecidomyiidae that we meet or are liable to meet on our growing economic plants may be of service to some of the members of our Association.

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P.S.—When I copied, a few weeks ago, from the report of Dr. Hewitt for the year 1914-15, the quotation concerning *Dasyneura rhodophaga,* I was far from thinking that when I would present this paper to you the late Dr. Charles Gordon Hewitt would have left us for the hereafter. I am really deeply grieved at his departure. It is very painful to think that such a gifted and learned young man is no more amongst us and that he will live only in our memory which will long recall his quiet behaviour and friendly way of imparting his extensive knowledge of Entomology.—J. C. C.

THE ESSENTIALS OF A DOMINION PLANT DISEASE SURVEY.

F. L. Drayton, Plant Pathologist, C. E. F., Ottawa.

Plant pathological work in Canada is severely handicapped on account of there being no organised survey of the plant diseases occurring in the Dominion. My main object in choosing this subject is to stimulate discussion, in the hope that many points of value in the carrying out of such a project may be brought up, and your wholehearted co-operation enlisted in helping to make a survey of this kind, which is to be put into operation this year, as comprehensive and as useful as possible. Dr. W. H. Rankin, Officer-in-Charge of the Dominion Field Laboratory of Plant Pathology in St. Catherines, has the organisation of this survey under his direction, and you will no doubt shortly receive some information from him on the subject.

In undertaking a project of this kind, the greatest difficulty is going to lie in the comparatively small number of possible co-operators in the Dominion in relation to the large area to be covered. It will necessitate commencing in a small

way and hoping that each year the number of co-operators will be increased, and consequently make the survey more extensive.

Most of the advantages to be derived from a well-organised plant disease survey would be familiar to you, but I am going to rapidly review them, so that later they may suggest to you points for discussion.

1. The rendering of assistance of fundamental importance to plant pathologists in their investigation work by:
   (a) placing at their disposal information demonstrating the problems requiring the greatest attention, and
   (b) supplying such information as prevalence, geographical distribution and severity, and so placing the chosen problem on a broad basis from which to build up lines of research.

2. An annual report by itself has considerable use, but its full value cannot be realised until it has become one of a series, recording year by year the fluctuations in amount and destructivenesse of any disease in accordance with changes of temperature, soil, moisture, etc., so adding to our scant knowledge of environment in relation to disease infestation and the possibility of being able to predict an epidemic through knowledge of the weather conditions found to be most favourable to an outbreak, together with the experience of former years as to the time of year when such an infestation may be expected.

Careful accumulation of data on epidemics would also lead to a better understanding of the conditions influencing the development, spread and control of such outbreaks.

3. It gives everyone the benefit of the experience of others on the resistance or susceptibility of certain varieties.

4. It disseminates results derived from various methods of control.

5. A record of the appearance of new diseases or the possible introduction of others from other countries is of extreme importance.

6. An organised survey would be a means of collecting information about any disease requiring immediate attention.

7. Last, but one of the most important, the education of the public to the importance of plant disease investigation by the published account of losses sustained from various diseases, and thereby assisting the plant pathologist to get recognition of his work.

The record of the presence of a disease is as important as the amount of material damage incurred. Positive figures are always extraordinarily difficult to obtain, but this does not matter so much provided that figures or terms are used which are comparable and always represent a similar standard. That is, "severe" or "20% reduction of yield" in Alberta should be exactly comparable to "severe" or "20% reduction of yield" in New Brunswick. It will take several years to determine which will be the best method of estimating losses and recording data, but this year the survey would have to be planned in such a way as would permit of the results being compared with the same data gathered by the United States

Department of Agriculture, where a plant disease survey has been in operation since July, 1917. Their practice has been to have one collaborator in each State who collects data from all the persons in that State whom he can interest in the work, and this material is forwarded to Washington for compilation. The method they adopt for reporting losses is in percentage of reduction in yield. Forms are supplied for recording this and other information relative to the survey, together with rules to be followed in arriving at the figures to be submitted. It is uncertain, at present, what form the publication of this data will take in Canada, but it is hoped that it will be published annually as a bulletin from the Division of Botany for general distribution.

The extent and the value of the piece of work will be dependent on the amount of co-operation secured. I would ask you all to give this matter your earnest consideration, and to make your criticism constructive rather than destructive, and render every assistance you can to establish this Dominion Plant Disease Survey on a permanent and beneficial basis.

THE ENTOMOLOGICAL RICHES OF QUEBEC

By Canon V. A. Huard, Quebec.

A title like the above doubtless may need some explanation, for it is not necessary that in reading it some innocent entomologist, on account of the simplicity expected to be met with amongst entomologists, imagines that he has only to run around the streets of Quebec, net in hand, to capture insects without number and of the rarest species. These pages are going to deal, not with living insects but rather with dead insects — with insects dead but preserved in certain methodical ways, otherwise known as an "entomological collection". I wish in other words to point out some advantages the entomologist will find at Quebec to help him in his studies. A brief account of the Quebec entomological collections will serve this purpose.

There are in Quebec but few private collections. In fact I do not know of any other than my own. Its principal characteristic is that it is fifty years old, which indicates sufficiently that its owner has for some time ceased to belong to the category of young men. The collection is a very considerable one and includes the product of my hunts in the vicinity of Quebec and also in that of the Saguenay where I resided for twenty-five years. What gives the greatest value to this collection is that it contains a large number of specimens identified by Provancher and among the Lepidoptera by Dr. McDunnough, the distinguished specialist in charge of the collections of the Entomological branch of the Department of Agriculture, Ottawa.

But I wish to speak here particularly about the large collections that one might term public, which are to be seen at Quebec and which are those of the Museum of Public Instruction and of Laval University.

Public Instruction Collection

The entomological treasures of the Museum of Natural History which belongs to the public instruction service of Quebec consist for the most part of the Provancher collections. But it contains also two other notable collections. One is the Saint-Cyr collection which is a general one, but not very extensive. It was formed by the late D. N. Saint-Cyr, who became the first director of the Museum of Public Instruction, and who studied botany much more than entomology. The other collection referred to is the precious Fyles' collection. Before going to reside at Hull, P. Q., the Reverend Dr. Fyles, one of the renowned entomologists of America, wished to leave in Quebec his collection of Lepidoptera, and the Museum of Public Instruction arranged to acquire it. Dr. Fyles worked for forty years in building up this collection, the result of his hunts in various parts of the Province of Quebec. It comprises more than two thousand species of Lepidoptera, some of which are of great rarity. One might say that it contains nearly all the Quebec species. It is all named, and as Dr. Flyes is a specialist, whom we know, it will be a source of authority for exact determination of our butterflies, if the classification were not still in an unstable state which makes it the despair of the amateur. In any event, the Fyles collection is a thing of beauty in its marvellous arrangement and in the perfection of the specimens which is contains, and which number two or three for each species.

A long time ago—that is to say 30 years—the Minister of Agriculture of Quebec obtained possession of his entomological collection, which was also later entrusted it to the care of l'Instruction Publique. One may say that this collection formed the nucleus of what is to-day the important Museum of Public Instruction. This collection, such as it was, still exists in the Museum of the Palais legislatif.

After the death of Provancher in 1892, the Government of the Province of Quebec obtained possession of his entomological collection, which was also placed in the Museum of Public Instruction. It was then that to my care was entrusted the preservation of the principal entomological collections of my regretted master and illustrious friend, collections which in former times I had studied under his direction, and which contained more than one specimen captured by myself.

These two Provancher collections are in a perfect state of preservation. They have a special importance and value from a scientific standpoint, because they contain the greater part of the TYPE specimens on which Provancher founded his hundreds of new species which he named and described in his publications. Notwithstanding the frequent modifications that scientific progress has brought into entomological classification, I have been very careful to make no changes in the arrangement and determination of these collections which, to my mind, should be preserved as a sort of historical monument. Further, and above all, these collections are to some extent like a commentary on the entomological treatises of

Provancher and should remain so. Thanks to the precautions which I have mentioned, it is then always possible to see at a glance about which species he wished to speak on such and such a page of his works, and that in spite of the changes which are being daily produced in entomological nomenclature.

I wish to add that the College of Levis also possesses a collection of insects acquired long ago from Abbé Provancher and which were the duplicates of his collection at that period.

Collection of Laval University.

The entomological collection of Laval University, which contains fifteen thousand named species, is one of the most important in Canada, and even of America. It was commenced about three quarters of a century ago by the late Mgr. T.-E. Hamel, one of the original members of the Royal Society of Canada, and who was for a long time rector of the University. Mgr. Hamel while one of our most zealous scientists was never a specialist in entomology; but that did not prevent him from taking part in the hunts after insects. I have been the witness of this in my younger days at the holiday residence of the Gentlemen of the Seminary of Quebec, at Saint-Joachim (Montmorency); it was even on these occasions that for the first time the existence of a science called entomology was revealed to me and it was there that the first germs of my vocation of entomologist were implanted in my mind.

The collections increased greatly during the years in which the late F.-X. Belanger, on the recommendation of Abbé Provancher, was appointed to act as curator of the Museum. He published at one time, in the "Naturaliste Canadien", some interesting articles on our native silk-worms. M. Bélanger died in 1882; I knew him well and used to see him walking about with his insect net in the neighborhood of Quebec. He was also an expert taxidermist.

The real curator of the University, who has filled this office for forty years is Mr. C.-E. Dionne, the author of "The Birds of the Province of Quebec", and who is not only a noted ornithologist, but also a learned entomologist. Under his direction, the entomological collections of Laval have been remounted and arranged according to modern methods. They have also, be it well understood, received considerable development. Mr. Dionne, who has much taste and skill, is also a taxidermist of wide reputation.

At one time the Laval entomological collections were united as a world-wide collection. In other words, the Canadian species were placed amongst those of foreign countries thus forming only a unique collection. This is a system which has its advantages from the view point of the general entomologist; but it has also many drawbacks, and it is far from being favourable to study. For the number of species known to-day in entomology is enormous, so that there are no longer "universal" entomologists. It is now necessary to specialize in the study of species of the single country where they live, and the longest life barely suffices.

in our days, to become thoroughly acquainted with the insects of the region where we pass our existence. Therefore Mr. Dionne has very wisely arranged the Canadian collections separately from the general collection.

Conforming with the method now followed, the entomological collection of Laval is preserved in boxes of small dimensions, hermetically closed, which are kept, after being classified, in fine glazed cases; and this arrangement permits one to find immediately the order and the family which one wishes to study.

The collections of Coleoptera, Lepidoptera and Hemiptera are the most important in the Laval museum.

Beside these collections intended for study, there are also in the museum, to gratify the curiosity of visitors, permanent exhibitions of speciments of the principal families of insects, and also groups of the various phases of the life and work of insects, which we know to-day under the name of "life-histories".

Although the museums of Quebec are not numerous and have not as yet the vast proportions and the riches of the large cities of the U.S.A. and of Europe, the Quebec entomologist can state with much pride and satisfaction that his favourite science is receiving special attention there. One may even say that it is entomology that is best represented in the museums of the Provincial capital. Further, the fact that the provincial entomologist has his laboratory in Quebec, and that other fact that Provancher worked all his life in the region of Quebec, as well as all his collections being preserved there; all these have contributed to give to the capital of the Province the distinction of being an entomological centre, whereof there should be a record kept in the history of the science.

THE EUROPEAN CORN BORER.

Prof. W. Lochhead, Macdonald College.

In the summer of 1917 the European Cor Borer was reported as doing damage to corn and other vegetable crops in a limited area in the vicinity of Boston, but during 1918 the infested area was found to extend over 400 square miles, and in August 1919 over 1100 square miles. Besides, the pest was discovered in Jan. 1919 about Schenectady, New York, where the area infested covered about 400 square miles, in August 1919.

In view of the alarming spread and menace of an insect that causes much damage in Europe a conference of the National Association of Commissioners of Agriculture with State Entomologists and Representatives of the U. S. Department of Agriculture was held at Albany and Boston, August 28-29, to look over the infested areas and to give careful consideration to all new points, both practical and scientific, relating to the extermination and control of the European

PLATE I

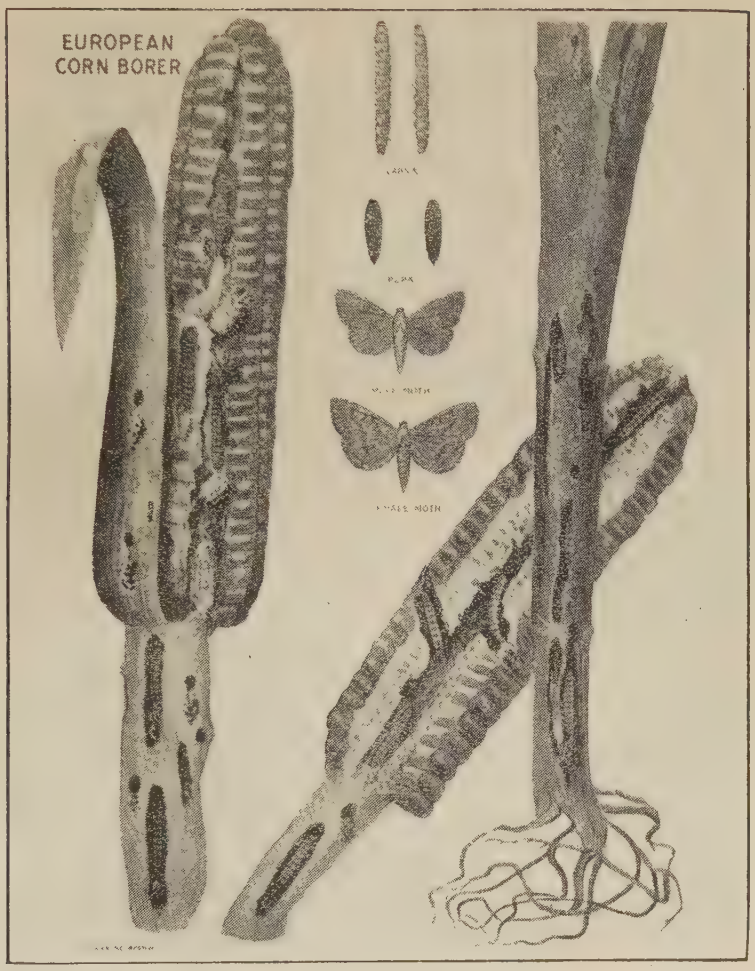


Fig. 1—The life-history of the European Corn Borer, from a colored poster published by the Mass. Com. Ag.

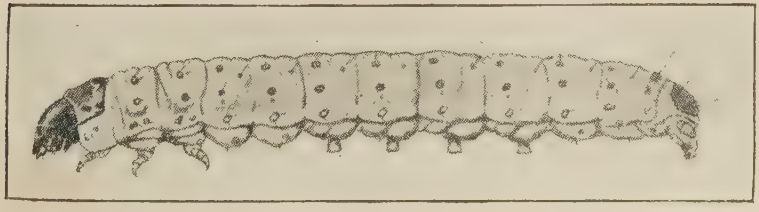
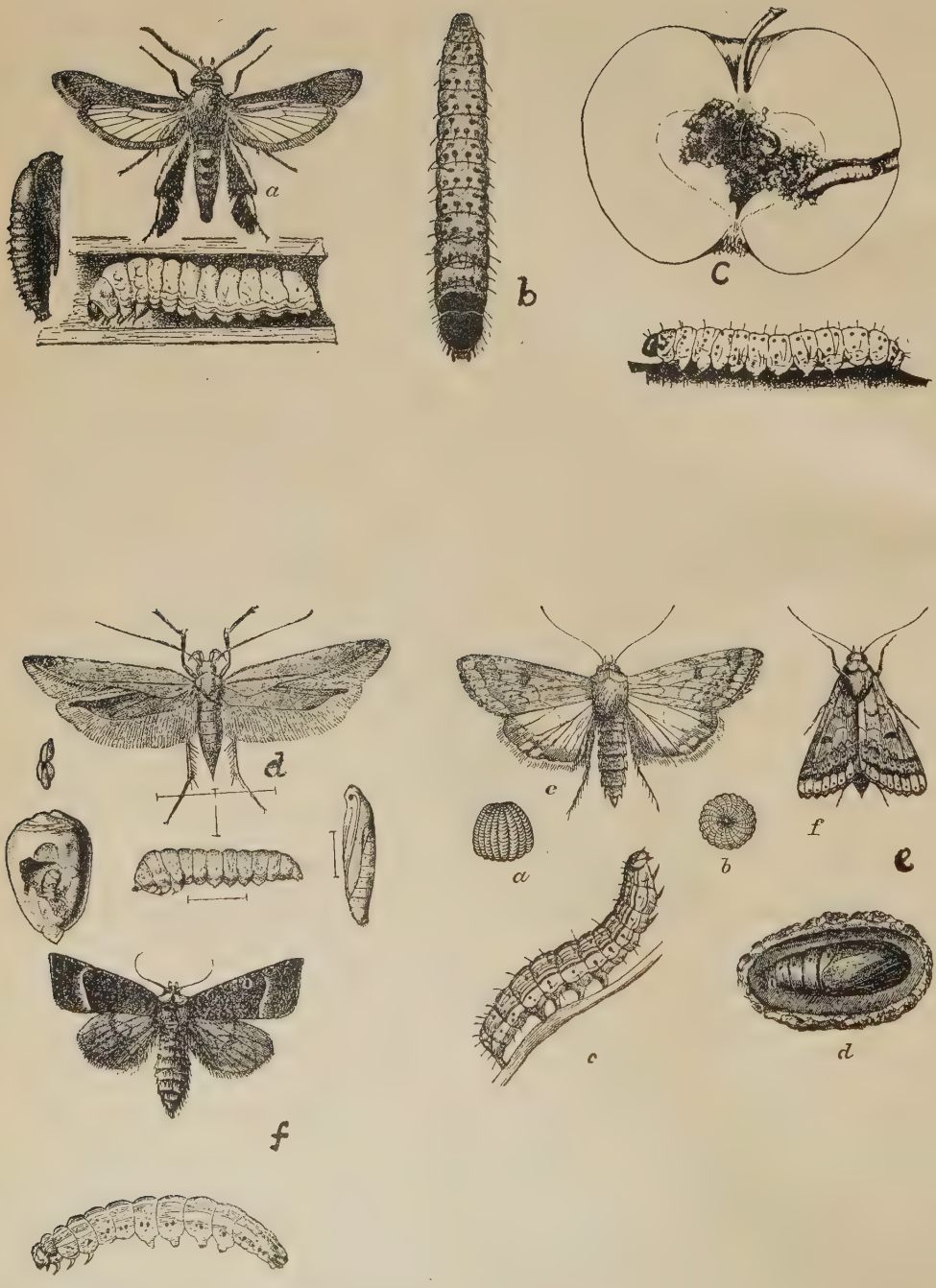


Fig. 2—Full grown larva of the European Corn Borer (much enlarged).



Lepidopterons borers.—a—Squash-vine borer; b—Parsnip web-worm; c—Codling worm; d—Angoumois grain moth; e—Corn-earn worm; f—Common stalk-borer.

Corn Borer. In response to the call a large number of State and Federal agricultural officials and state and federal entomologists attended the conference. Canada was represented by Dr. C. G. Hewitt and L. S. McLaine of the Entomological Branch, Ottawa, and the writer.

The Menace of the European Corn Borer.— At the first conference at Albany, presided over by Hon. Chas. E. Wilson, Commissioner of Agriculture, Albany, Dr. Howard, U. S. Entomologist, discussed the Status of the Corn Borer as a Pest, and Hon. Chas. Adkins of Illinois pointed out the damage that would be done to the corn industry of the U. S. if the corn borer were not controlled; the losses would be enormous on account of the great value of the corn crop.

The European Corn Borer.—a—the parent moth; b—eggs in flat masses on under surface of leaf; c—broken tassel with extrusion of saw-dust-like material; d—infested ears; e—infested stalk with extruded saw-dust-like material; f—borer in a stalk; g—the hibernating borer in stubble and stalks; h—pupa in stalk. (After Snodgrass).

At present the infested areas are quarantined so that no corn can be removed from the areas. Inasmuch, however, as the insect feeds upon and breeds in barnyard grass, ragweed, pigweed and many other vegetables, weeds and grasses, the problem of extermination becomes a very difficult one, and as there are many ways by which the insect can spread—by flight, in ears of corn, in garden vegetables, etc., the possibility of spread to other states is quite readily admitted. Even Canada is not exempt from invasion, and steps will probably be taken to "scout" the border counties.

The Life History of the European Corn Borer.—At the first conference in Albany, Dr. E. P. Felt, N. Y. State Entomologist, gave an interesting account of the life history of the insect and a summary of the recent work about Schenectady in relation to the extermination of the pest, while at the second conference at the State House, Boston, Commissioner W. Wheeler of Mass. and Prof. D. J. Caffey, scientific assistant in charge of the Investigations, discussed the facts that had been revealed in the two years' work with the European Corn Borer in Massachusetts, and the plans for eradication.

The insect winters over as a nearly full-grown caterpillar in corn stalks and some of the large weeds. About the middle of May it pupates and emerges as a moth which lays a large number of eggs in shingled batches on the underside of leaves. The caterpillars from these eggs feed upon early corn and weeds. About the last of July these caterpillars pupate, and early in August another generation of moths appears. These lay their eggs principally on corn and the caterpillars do a large amount of damage, feeding on the stalks and ears of corn. These caterpillars or borers pass the winter in corn-stalks and large garden weeds.

The full grown caterpillar or borer is about an inch long. The head is black and the upper surface of the body brown. Each division bears a row of small dark-brown spots, while several pink lines run lengthwise of the body. (Fig.)

The pupa is cone-shaped, brown and about half an inch long.

The moth is pale yellow, expanding a little over an inch; the female is more robust than the male, and has the markings on the wings slightly different.

As the females of the first brood of moths lay on an average about 350 eggs each, and those of the second brood about 550, it is quite possible for an overwintering caterpillar in an old corn stalk or weed to be responsible for 100,000 borers up to the first of September.

Method of attacks by the European Corn Borer.— The members of the Conference had an opportunity of studying at close range the work of the pest, both in the Scotia district about Schenectady N. Y., and in the District to the north of Boston in the towns of Arlington, Medford, Melrose, Saugus and Malden, where much damage had been done to sweet and dwarf varieties of corn. Autos were provided so that many of the infested fields were inspected.

The Corn Borer tunnels through all parts of the corn plant except the fibrous roots. It causes most serious damage, however, by its work in the stalks and ears, which it partially or totally destroys. Generally it enters the stalk near the base of the tassel and at first tunnels upward. This damage so weakens the tassel that it breaks over before it matures. These broken tassels, with extensions of sawdust-like material at the breaks, are the most conspicous signs of infestation in a field.

Tunnels are also made downward in the stalk, and when several borers are present, as is frequently the case, the stalk is reduced to a mere shell. The ears of corn are also attacked, and the inspectors have found as many as 15 fullgrown borers feeding upon and within a single ear.

Some idea of the extent of injury to corn plants may be gained from the following statement by Professor Caffrey: "Seventy-five plants, comprising 17 hills, were selected at random from a badly infested corn field at West Medford, Mass., and all the borers found therein were carefully removed and counted. Forty-six borers ,on an overage, were found in each plant, and one of the plants contained 177 borers".

In addition to corn, the stalks of celery, beets, turnips, potatoes, Swiss Chard, beans, spinach, chrysanthemums, gladiolus, geraniums and oats are entered and damaged by the borers.

The Control of the European Corn Borer.— From the foregoing evidence two facts stand out prominently, viz.—*the destructiveness of the European Corn Borer, and the difficulty of finding adequate means of control.* The States of Massachusetts and New York, with the assistance of the federal government, have carried on a vigorous warfare, and in addition to the destruction of infested plants they have quarantined the infested areas.

As the borer passes the winter in corn-stalks and weeds, very effective destructive measures have been carried out *by pulling up and burning all corn stalks together with all old vines and all large weeds throughout and around the gardens during fall, winter and early spring.*

In the district about Boston, however, where the population is dense and the gardens numerous, such measures of destruction present enormous difficulties. New devices for fighting the borer have been tried by the experts in charge of the control work. Two new machines in action were exhibited to the members of the Conference.

One of them was a liquid fire machine, which aroused great interest. There is a powerful pump on wheels to supply the power and a low spraying machine, also on wheels, to distribute the crude oil, which is ejected through 16 nozzles.

The oil is set on fire at the start and as it is dragged over the ground a great sheet of flame covers the surface, emtitting a loud roar and shooting a tremendously hot blaze into the air. This machine is dragged through tall weeds, and while it does not actually consume all of the green vegetation, it destroys every trace of insect life.

It is believed that this machine will be very successful in cleaning up infested tracts of land, especially in the Fall and Spring. The other machine demonstrated works like a mangle. Suspected plants are cut or pulled up, then thrown into the machine where they are crushed between the rollers.

Is the Corn Borer a Menace to Canada ?—The question naturally rises : Will the European Corn Borer reach Canada and become a destructive enemy of corn, seeing that it will be single-brooded? With the history of the pest in Europe, New England and New York to guide us we believe we are warranted in stating that if precautions be not taken in time it will reach Canada in a few years and cause considerable loss. We should, therefore, do everything that lies in our power to exclude it. In spite of the quarantine restrictions in Massachusetts and

New York live specimens of the insect may find their way to Canada through the agencies of winds and commercial importations. The best policy for us to pursue is to make known as widely as possible by posters the appearance and habits of the borer and to "scout" the counties bordering on New England and New York so that all incipient outbreaks may be "nipped in the bud". (Fig).

The Recommendations of the Conference.

At the conclusion of the two-day conference in which the European Corn Borer was studied from all possible viewpoints, the special Committee appointed to suggest a policy of action in relation to the pest submitted the following report which was adopted unanimously by the Conference.

Boston, August 29, 1919.

WHEREAS the European Corn Borer has become well established in both Massachusetts and New York State, and, during the past two years, has seriously damaged both sweet and field corn in Eastern Massachusetts; and

WHEREAS it has spread rapidly this season and will unless speedly checked in both states, spread quickly over large areas heretofore un-infested and in a few years may cause enormous losses which might run into millions of dollars.

WHEREAS, we, the National Association of Commissioners of Agriculture, with official entomologists from many states and representatives of the United States Department of Agriculture, together with representatives of the Canadian Government, present as experts in conference upon the situation, express ourselves, after examining the infested area, as thoroughly convinced that this pest is one of the most dangerous insects which has become established in America, and we hereby place ourselves on record in favor of most energetic efforts on the part of Federal and State agencies to control, and, if possible, exterminate this insect, including in the program vigorous quarantines to prevent its distribution.

The danger of spread is so great, the probabilities of successful control under American conditions so unpromising, that we unhesitatingly recommend most energetic measures to control this very serious enemy of our principal grain crop. The immensity of the interests threatened leads us to advise a comprehensive plan of action which may involve the expenditure by the general government of much larger sums than are recommended in these resolutions.

We urge the present Congress to appropriate and make available for use as rapidly as an effective organization to carry on the work can be secured and developed, in addition to funds already available, two million dollars, the sum to be requested for the calendar year of 1920 to be determined by the future development of the work.

We would at this time call attention to the necessity of all Commissioners of Agriculture and Entomologists throughout the United States of America and Canada taking an active interest in this insect, and we would hereby urge the dissemination of information respecting the situation by the appropriate agencies in each state and by the Federal Government.

We would recommend for the purpose of promoting the control and extermination of this borer the appointment of a committee representing the Comissioners of Agriculture, official Entomologists and the Plant Pest Committee for the purpose of unifying and directing all efforts for securing of appropriations and to aid in the determination of a comprehensive policy.

COMMITTEE

C. P. Norgord, Madison, Wis.
Chas. McCaffree, South Dakota.
Wilfrid Wheeler, 136 State House, Boston.
E. P. Felt, State Museum, Albany, N. Y.
Geo. A. Dean, Manhattan, Kansas.
R. W. Harned, Agricultural College, Miss.

Later Conferences.— Since the Albany-Boston Conference in August, 1919, several meetings of entomologists and Federal and State officers have been held for further consideration of the Corn Borer problem. One of the most important discussions took place at the 32nd Annual Meeting of the Association of Economic Entomologists at St. Louis, where the results and doings of the year 1919 were reviewed very thoroughly, especially by Dr. Felt, Entomologist for New York State, and Dr. Marlatt, Assistant Chief of the U. S. Bureau of Entomology and Chief of the Federal Horticultural Board. Two important points were brought out:—viz. 1. that the Corn-Borer was double-brooded in Massachusetts and single-brooded in New York State; 2. that the area of infestation in December 1919 was 1900 square miles in Massachusetts, 20 square miles in New Hampshire, 500 square miles in the Schenectady district and 400 square miles in Western New York; and 3. that the only kinds of corn that have been shown to be damaged to any appreciable extent are sweet corn and the dwarf flint varieties.

Regarding the habits of the Corn Borer, investigations in Massachusetts in 1919 show that individual females may make a single flight of 287 yards, and that marked individuals were recovered at a distance of 600 yards. Moreover, females may live 33 days, and deposit eggs in small masses during a considerable part of this period—the maximum egg production of one individual being 1192.

Although the insect breeds in about one hundred kinds of plants — weeds, garden and cereal plants, it multiplies freely upon relatively few plants.

It seems that the Corn Borer was introduced into the United States in the years 1909 and 1910, for in those years nearly 10,000 tons of broom corn were imported, chiefly from Austria-Hungary. Of this importation 500 or 600 tons went to a factory in Boston, and a like amount to Schenectady, N. Y., but approximately eight-tenths went to New Orleans, St. Louis, Chicago and other points in the Mississippi Valley and were distributed from these centres to many broom factories. There is, therefore, a great likelihood that the insect has been distributed in this great corn-growing area. For various reasons, practically no effort has been made thus far to "scout" the Mississippi Valley for the Corn Borer.

consequently the corn-growers of those Middle States are naturally impatient at the apparent slowness in determining whether or not the Corn Borer has obtained a foothold.

At the St. Louis meeting differences of opinion were expressed as to the amount of damage the Corn Borer was capable of doing. It would seem that the common coarse field corn is not attacked; if this should turn out to be the case, the possibility of damage in the great corn states is small. Moreover, single-broodedness for the northern areas of corn culture, the possibility of cultural control by the elimination of weeds, and the possibility of effective egg parasitism by *Trichogramma minutum* which destroyed some 43 per cent. of the egg masses of the second brood in Massachusetts in 1919, are all hopeful factors in the situation.

On the other hand, it was pointed out by several entomologists that inasmuch as the importance of the Corn Borer has not yet been definitely determined, and there is a possibility of its being a very serious pest, the authorities should do everything in their power *now* to control it and to prevent its distribution. The action of the federal bureau, however, in asking Congress for half a million dollars instead of two millions recommended at the Albany-Boston Conference was criticized.

Dr. Marlatt, in defending the attitude of the Bureau, said that the program and policy of the Department of Agriculture is: "to make as promptly as possible a thoroughgoing investigation to determine the actual necessities of the case and the possibilities of control. The first consideration under this plan is the determination of the distribution of the insect; the second, to demonstrate on a large scale what may be done to control it; and the third, to co-operate with the several states in quarantine and other measures to prevent spread." He considered that under the circumstances it was unwise to ask Congress for more than half a million.

Insects liable to be mistaken for the European Corn Borer.

As many lepidopterous borers of minor importance occur in the stems of plants they are liable to be mistaken for the European Corn Borer. It is, therefore, important to be able to distinguish the former from the latter.

The more common lepidopterous borers may be grouped as follows (after Mosher, *Journ. Econ. Ent.*, June, 1919):

Aegeriidae—Melittia satyriniformis—Squashvine borer.

Tortricidae—Many Eucosmids—Codling Moth.

Gelechiidae—Phthorimaea operculella—Potato tuber moth; Metzneria lapella—burdock borer; Sitotroga cerealella—angoumois grain moth.

Oecophoridae—Depressaria heracliana—Parsnip webworm.

Phycitidae—Elasmopalpus lignosellus—Lesser cornstalk borer.

Crambidae—Diatraea zeacolella—Larger conrstalk borer.

Pyraustidae—Pyrausta nubilalis—European Corn Borer; Pyrausta penitalis—Polygonum borer.

Noctuidae—papaipema nitela—Common stalk borer; Papaipema cataphracta; Heliothis obsoleta—corn ear worm; Achatodes zeae—spindle worm. (See Illustration)

Besides the more obvious differences of size, color, etc. the caterpillars of these moths may be distinguished, as Miss Mosher has done, by the arrangement of the ocelli, the setae, the clear areas, and the hooks of the prolegs.

SPRAYING TO INCREASE POTATO PRODUCTION

Prof. Georges Maheux, Provincial entomologist, Quebec.

It has been thought heretofore that the only means of raising more abundant potato crops were confined to the *fertilization of the soil* and to the *choice of cultural methods.* Numerous progressive farmers are however realizing that it is not quite so simple, and that in order to succeed with such an important crop, special attention must be paid to the *selection of the seed* and to the *proper protection of the growing plants.*

It would be difficult to determine which of these factors has the greater bearing upon the yield. Both have an unquestionable influence; but it is also known, from the results of numerous experiments, that the selection of seed and the protection of plants by sprayings will insure success. In our opinion, protection means production; protecting according to established rules is practically carrying on a permanent greater production campaign, besides being the assurance of having fine products and big returns.

Besides, the question of the protection of crops has assumed considerable importance in the Province of Quebec during the last few years. For a long time it had been thought that man could devise no efficient means to control parasites. Moreover, if the havocs worked by the Colorado potato beetle were obvious to all, it had struck the mind of practically none that fungoid diseases, which surrepticiously creep into the fields and often ruin the crops, could leave the farmer any other alternative but that of groaning over an endangered or destroyed crop.

In order to overcome these beliefs and this ignorance, prejudicial to agricultural welfare, we have thought it advisable to undertake an educational campaign. Our idea was to enlighten the minds of the farmers and slowly to bring them to realize the importance of protecting their crops in an efficient manner. We particularly tried to get them to understand to what extent pests and epidemics of fungous diseases could bring to nought the most laudable efforts and diminish the yield.

But then, we had to give striking and indisputable examples of what we were setting forth. At the start, a series of occasional demonstrations was given. If a general campaign had been undertaken covering all threatened plants it would certainly have resulted in a failure. It was thought the object could be attained better by selecting one particular crop.

One of the most common crops to-day in our Province and one of the most remunerative is surely that of potatoes. Official statistics clearly show that for three years, the acreage, the yield and the value of this crop have not ceased increasing:

Year	Acreage	Yield	Average Yield	return Average	Total value
1917	226,917	18,158,000	80.02	$1.38	$25,058,000
1918	264,871	38,936,000	147.00	0.98	38,157,000
1919	315,590	57,280,000	181.50	0.85	48,688,000

These figures are eloquent proof of the importance this crop has assumed in our Province as well as of the continuous increase of the average yield per acre. It may be stated, without any fear of error, that this increase corresponds to the ever-generalizing use of protection methods. If only one third of this increase since 1917 be put to the credit of sprayings the net returns realized from this source would reach, this year, $8,000,000 or one-sixth of the total.

On the other hand, taken as total value, the potato crop compares favorably with other crops in the agricultural statistics. It comes third, next to *hay and clover valued at* $32,462,000 in 1919, and *oats valued at* $60,712,000. It might be remarked that the average price of potatoes, figured at $0.85, is rather low. At the price they sold this winter, often as high as $3.00 per bushel, the average price would easily reach $1.00 and the total value would be estimated at $58,000,000.

Unfortunately, this crop which has become so remunerative, has many enemies. Already weakened by the injuries of insects it nevertheless pays a heavy debt to diseases, late blight particularly. These were sufficient reasons to induce us to make the protection of plants more popular.

The ground had been well prepared by the occasional demonstrations started in 1917 and subsequently given by agricultural instructors. They, however, proved inadequate in view of the increasing needs. I previously had the occasion to show what influence they had upon the minds of several farmers; but in order to have the methods of control enter into the farm management, demonstration or experimental fields were organised in 1919 with the assistance and under the supervision of district representatives.

In 40 counties, 60 fields were established. According to our programme, each field had an area of one acre, divided in two even plots of half an acre each; a check plot being provided close by. Each plot was to be sprayed at least four times. The first plot was treated with poisoned Bordeaux mixture, the second was sprayed with lead arsenate. The necessary insecticides and fungicides as well as a Gould knapsack sprayer were supplied by us.

In spite of the difficulties inherent to a new organisation, the sprayings were given regularly almost everywhere. However, uncontrollable delays were occasioned by the fact that there was only one sprayer available for two or three fields.

Results have however gone far beyond our expectations. The fields presented a fine appearance everywhere, insects were kept under perfect control and very few injuries by diseases were noticed. The disease which was most conspicuous was late blight although a few cases of mosaic were also reported.

The gratifying results achieved by this undertaking may be emphasized from three different view points: the yield, the purchase of sprayers and the increase in the number of those fields for the current year.

Yield.—Harvest time was earnestly looked for. Nowhere have we had any disappointment. Plot A (treated with poisoned Bordeaux mixture) gave an average yield 50% higher than that of the check; plot B (on which insecticides only were applied) gave an average of 35% over the check. The following are a few figures taken from reports received by us:

Place	Number of sprays	Yield		Yield per acre			Increase	
		Plot A	Plot B	A	B	C	A	B
Plessisville . . .	4	132	110	264	220	170	50	30
Saint-Prime . .	5	120	105	240	210	125	96	68
Katevale	5	106	98	204	196	160	28	23
		Average.....		244	209	160	58	40

The grading of the crop took place in the first part of November at several places. The following result was obtained at Katavale:

Healthy tubers, plot A — Healthy tubers, plot B — Healthy tubers, check
100% 70% 50%

The additional revenue contributed by spraying in those 60 fields amounts to $3060 for Bordeaux mixture and to $1,800 for lead arsenate. The average cost of spraying in each field was estimated at about $15.00 (labor included), leaving a net profit of $30. per acre over the check plot.

Purchase of sprayers.— In view of such conclusive results several farmers have made up their mind to get sprayers; in some place 20 persons have already done so. I believe this is one of the best proofs that this experiment has been fruitful. It moreover goes to show that the principle of protection of crops is about to take root in this province; and once adopted on a farm it will last forever.

New fields.—We had intended extending our operations this year. District representatives have received so many requests that 500 of these fields would be required to meet all demands. We have thought that it would be rather difficult for a district representative to properly control more than 4 or 5 of these fields; this will make a total of nearly 200, which will be enough for those who are called upon to supply the necessary material.

This year the work will be completed by the formalin treatment; if, by this means potato crops cannot be increased, we, at least, hope to show that they will be of a better keeping quality; thus ensuring the highest quality of the next crop. crop.

This treatment with formalin will equally apply to oats. About one tenth of the oat crops are lost every year through injuries by smut; which means that $5,000,000 or $6,000,000 are thus lost.

We particularly intend to retrieve such a considerable amount and hope to be successful at least to a certain extent.

Many among you will probably think that it must be rather tedious always to preach the same thing, and to be constantly bent on such elementary work.

In view of the results obtained, which clearly denote the advantages to be derived by the farming community, several will recall to themselves, as I personnally do, that this should be our object and that nothing could be more gratifying to us.

SOME PLANT DISEASES IN THE GREENHOUSE

Professor B. T. Dickson, Macdonald College.

During the past Autumn and Winter 1919-1920 several plant diseases have been prominent in the greenhouse at Macdonald College, Quebec, and a brief account of these may serve a useful purpose. The host plants concerned will be dealt with in alphabetical order.

Carnation (*Dianthus caryophyllus L.*)

Rust caused by *Uromyces caryophyllinus* (*Schrank*) *Wint.* was present throughout the crop but affected principally the slips.

The fungus is propagated principally by urediniospores which are more or less ellipsoidal, 24 to 35 by 21 to 26 microns, slightly echinulate and light brown in color.

Potassium sulphide 1 in 1000 is a useful control.

Cineraria (*Senecio cruentus L.*)

There was an especially fine show of Cinerarias, the plants in most cases reaching a height of 3 feet and having a spread of bloom from 1½ to 2 feet in diameter. Among the plants were representatives of three types:—the ordinary horticultural type with ray florets about 2 cm. long by .8 cm. broad (Plate III), a stellata type having smaller flowers with ray florets 1.3 cm. long by .35 cm. broad, and a cactus type, apparently newer, in which the ray florets did not unfold but remained with the edges rolled back as is well shown in Plate III.

Several noticeable features distinguished this last variety from the other two, long before flowering occurred. The plants were small, not growing more than I foot in height and in many cases not more than eight inches. Their leaves were smaller and since the plant was shorter, tended to a leaf mosaic arrangement. This gave rise to considerable variation in petiolar length. When flowers did develop the flower mass was spindly and more open than in the case of other plants, (Compare Plates IV and V) and considerably less in size.

"Cactus" type of Cineraria flower. (Original)

Ordinary Cineraria flower. (Original)

PLATE IV

Healthy "stellata", type of Cineraria. To show normal size of plant and flower clusters. (Original).

The chief characteristic however was the development of a "mosaic-disease" appearance in the leaves. Certain areas in the leaves developed more rapidly than the remaining parts, resulting in blister-like distortions. These areas, plainly seen in Plate VII were of a much darker green color than the surrounding areas. They did not appear in any definite locations in the lamina, being sometimes more numerous nearer the petiole, sometimes nearer the leaf margin and at others scattered irregularly. In all cases, however, they were limited fairly clearly by the veins.

As the plants neared flowering time all the younger leaves showed these strikingly darker areas. No insect pests were present in the greenhouse and no punctures could be observed which might account for the appearance of such distortions. Preliminary tests showed that there was a tendency for the darker portions to retain starch.

Enzyme tests are in progress as also are infection trials. So far none of the latter give satisfactory results since in the apparently successful cases there is still the possibility that he pants were already affected. An interesting fact was noticed with regard to the trichomes. In several cases the trichomes in the lower surface of darker areas had a considerably higher anthocyanin content than normal. No cases of leaves showing these areas occurred in the other two varieties of plants.

All received the same treatment in every respect. It may be that the "cactus" variety is really a diseased variety.

Snapdragon (*Antirrhinum majus L.*)

Snapdragon rust caused by *Puccinia antirrhini* (*D. and H.*) was very abundant, hardly a plant escaping infection. Seedling, cuttings and mature plants were attacked in all stages of growth. The disease was propagated by urediniospores and but few teliospores were found. The uredinia occurred on the lower surface of the leaves as a rule but there were several cases of such severe infection that pustules appeared on the upper surface also.

The mycelium is localized giving rise to more or less circular diseased areas on the leaves (see Plate VI) and to longer elliptical areas on the stems. The urediniospores are from 22 to 30 by 21 to 25 microns, yellow to brown in color, echinulate to warty and possessing usually two germ spores. They germinate readily in water in a few hours. Frequently they have been germinated in an hour. The plants are rendered unsightly for market purposes by the presence of the uredinia and when infection is severe the leaves are rapidly killed (Plate VI, Fig. 2), resulting eventually in the death of the plant.

It is recommended that clean seed be used as no fungicidal control is yet known, so that it is difficult to obtain clean plants by propagating from cuttings.

Sweet Pea (*Lathyrus odoratus L.*)

The greenhouse grown sweet peas suffered severely this season from powdery mildew of which the causal organism is *Microsphaera alni* (*Wal.*) *Salm.*

The lower leaves were first affected and the mildew gradually spread upwards. Affected leaves were covered with a dense white mycelium and conidia were abstricted profusely.

Tomato (*Lycopersicum esculentum Mill*).

The chief tomato disease was "mosaic" indicating in all probability that the variety propagated was running out. This view was supported by the reduced yield as compared with previous crops.

Leaf Mold caused by *Cladosporium fulvum Cke.* was also prevalent especially towards the latter end of the season.

Violet (*Voila odorata*).

Leaf spot caused by *Alternaria violae G. and D.* was very destructive, the leaves being in most cases killed. The spread of the disease was checked by the use of Bordeaux but spraying the plants with Bordeaux spoils the foliage for commercial purposes. Careful attention at watering time is essential in the greenhause.

ECONOMY IN SPRAYING

Rev. Father Leopold, Oka Agric. Institute.

Spraying is one of the most important practices in fruit-growing; in fact, I believe that it is the most important. You may not care to go to the trouble of cultivating the soil of the orchard, to put in a cover crop, even to prune, but if you wish to market first class fruit, you must spray.

With every item in orchard practice to-day costing much more than a few years ago, it is up to the fruit-grower to practise the strictest economy in all his operations, but especially is this so of spraying with ECONOMY IN SPRAYING.

Economy.—What I mean by economy, you readily understand, is not to spare anything when the time of spraying has arrived or not to put on each tree the quantity and the quality of either dust or liquid applications.

1.—*Economy procured by thorough pruning.* It is evident that in an orchard which is not regularly pruned and well pruned there is a great loss of time and material in applying unduly liquid or dust sprays to parts of trees which should have been eliminated prior to the spraying of each tree. But that is not the main point.

Both insects and fungi harbor on the litter and rubbish distributed on parts of the tree which should have been previously removed by thorough pruning. Preventing the spores of diseases from germinating and the eggs of insects from hatching are so much done in the prevention of pests that may require considerable spraying to overcome. We overlook this point too frequently.

Insects and fungi harbor also on the litter and rubbish distributed on the ground and particularly in the accumulation of growth and litter along fence rows

Fig. 1—To show dwarfed growth of plant having leaves affected as in Fig. 1. Note spindling flower clusters. (Original).

Fig. 2—Severely affected plant. Disease spread by method of watering. (Original).

Fig. 1—Illustrating the circular pustules on the underside of Snapdragon leaves. (Original)

Fig. 2—Severely affected shoot of Snapdragon. (Original)

Fig. 3—Rust sori on Calyx of Snapdragon. (Original)

surrounding the orchard. Raking up and burning such litter is good orchard practice and economy in spraying also.

In the application of the materials with which we spray there is considerable saving done and fungi prevented from propagating if in pruning we reduce reasonably the producing area of wood and thus open up the trees to admit sunlight and air.

2.—*Economy in getting the material on time.* There is nothing that is so discouraging to a fruit-grower than not to receive his insecticides or fungicides *on time.* There is no other way to avoid disappointment than to order these fully two months before actually going into the orchard with the spraying rigs. It is very bad *economy* to put off the ordering of insecticides and fungicides under the pretext that perhaps prices may come down. We risk too much in not getting the sprays on the trees on time in delaying so. Spraying must be looked at as an asset and an insurance which is abolutely needed every year for success in the orchard.

3.—*Economy in the spraying rig.*—There are spraying outfits suited for every orchard and it is bad economy to rely on a small hand-pump outfit for any orchard over 10 acres. There is such a thing as wanting to do things well with bad outfits. As success in spraying, and I mean the fact of spending so much time and money doing the work, depends on placing the material on the trees *on time,* how can you expect to go around any large orchard, do the work well and thoroughly, with a small outfit? There is no use spraying for codling moth after the calyx sepals have reunited on the small apples. This calyx spray in particular must be done thoroughly and quickly, and in very large orchards, I am of the opinion that a dusting machine may be necessary some years when time is scarce, on account of the soil being so sogged with rain water that a large spraying outfit can not be easily and quickly hauled over the orchard in time to treat all the trees. This is just one instance I mention here.

It is not good economy to wait until spraying time to overhaul the spraying outfits. At least a month before the actual time of spraying, the spray pump should be thoroughly overhauled and cleaned up. All worn and damaged parts should be replaced. This may require time to do, especially if it is necessary to get new parts from a distance. The nozzles, hose, rings of the "spray gun" also should be inspected and defective parts replaced. A coat of paint on the spray tank and pump will more than justify the expense and trouble. It is good economy also to have on hand extra parts that we know we may need during the spraying season. It is very *bad economy* to have to stop spraying one day or two, if not more, right in the height of operations, on account of some important part of the pump that does not work smoothly.

4.—*Spraying material.*—Here I am coming to the main point of this paper, and there are a few points that I wish to emphasize strongly today. There are too many spraying materials recommended to our fruit-growers and farmers to be able to spray economically to-day. It seems that some means should be found by our Society and by the Provincial Entomologist that could enable our farmers and fruit-growers to buy co-operatively all their *insecticides* and *fungicides.*

Even for such men as college professors and men who have done considerable spraying, I admit this for myself at least, it is quite a problem to decide where we will buy our insecticides and fungicides, what we will use so as to get the fullest possible benefit from and at the same time not pay too much for what we buy. I do not know if you have ever gone into the trouble of getting different quotations from the most reliable dealers of spraying materials. I have and it is surprising to find the difference which can exist in such prices. Here are a few exemples. (Read these on the original quotation slips).

Another point is this. Some of our farmers and fruit-growers are still using expensive material when we know, as a Society, that there is no use for such. I have not bought a pound of Paris Green for our orchard for 10 years. I am of the opinion that Paris Green should not be recommended, or even spoken of any more, in connection with the spraying of Potatoes, when we can have such an economical insecticide as arsenate of calcium which is safe with potatoes with or without Bordeaux, if we add 5 pounds of Hydrated Lime to 40 gallons of water. Paris Green just costs double the price of Arsenate of calcium in powder form. We have even dusted successfully acres of potatoes with a preparation of 10% Arsenate of calcium and 90% Hydrated Lime when bugs were too abundant, and with great success, without the least burning of the leaves.

AN IMPORTANT BIOCLIMATIC LAW

W. Lochhead, Macdonald College.

At the Annual Meeting of the Entomological Society of Ontario, held in Ottawa in November last, I presented a paper on "Hopkins' Bioclimatic Law" with the object of showing the value of this Law in the investigation of certain biological problems such as the distribution of the fauna and flora and the control of certain injurious insects.

The term "Hopkins' Bioclimatic Law" is not strictly correct for the Law was not discovered by Dr. Hopkins as he himself distinctly states in his monograph, *Supplement 9 of the Monthly Weather Review*. But he amplified the Law and applied it to this continent. By means of maps and charts he made it clear that it was possible by utilizing the information thus obtained to secure greater production of crops. In the matter of wheat production, for example, he was able to tell the farmers the best date to sow their wheat so as to escape the Hessian Fly and to get maximum production.

My object in bringing this Bioclimatic Law to your attention is to get your co-operation in the matter of the collection of phenological records for Quebec. Before charts can be made and the full details of the Law can be applied to this province, as Hopkins has done for many of the States, many thousands of reliable records covering a series of years must be secured from all parts of the province.

Fig. 1—Two leaves from mosaic diseased tomato plants. The characteristic growth is clearly shown. The bulging areas are a very dark green and the intermedite areas a pale yellow green. (Original).

Fig. 2—Cineraria leaves from "Cactus" type showing darker areas bulging on upper side of leaf. (Original)

We have an interesting province from a climatic point of view for the great estuary of the St. Lawrence has an important influence in modifying the intensity of the larger controlling factors of latitude and altitude. I believe I am not too optimistic in stating that if the local influences of topography, exposure, prevailing winds, sunshine, rain, soil, etc., were thoroughly studied, many important improvements could be effected in the growing of crops. As Hopkins says: "There is a northern, southern, and altitudinal limit to the profitable culture of crops between which there is an optimum zone for the most profitable culture. By means of computing tables these limits and optimums can be approximately determined and shown on maps to serve as a guide to research and practice in determining the facts as related to regional and local conditions."

The Bioclimatic Law.

This law represents the "general laws of climate as affecting the seasonal activities and geographical distribution of plants and animals, periodical practices in Agriculture and the adaptation of farm crops to the requirements of climatic conditions." It may be stated as follows: The variation in the time in which periodical events occur in the seasonal development and habits of plants and animals, at different geographical positions within the range of their distribution is, *other things beings equal, at the rate of four days for each degree of latitude, five degrees of longitude or four hundred feet of altitude.*

Accordingly, lines running from the east toward the northwest at the rate of one degree of latitude to five degrees of longitude represent the same constant or average date of a periodical phenomenon for any given level throughout the length. Such lines Hopkins calls *isophanes.* He has constructed an isophanal map of the United States, with phenological meridians, five degrees apart but at right angles to the isophanes. By means of an accompanying chart for altitude he shows how constants may be computed, for the three combined factors, latitude, longitude and altitude. As the effect of local accelerating or retarding influences such as topography, lakes, large rivers, winds, etc., modify the computed average of the constant for each quadrangle, such departures for both spring and autumn have been determined and marked on each quadrangle of the isophanal map. Such determinations were based on 40,000 reports from all parts of the country on the beginning of wheat harvest.

A detailed study of the altitude limits of species and of biological associations of plants and animals as mapped by the U. S. federal and state biological surveys served not only to verify the evidence furnished by the wheat harvest records but to establish, as a general principle, the approximate amount of variation we may expect to find in all regions from those in which there is no perceptible retarding or accelerating influence to those where the intensity of the influences reaches its maximum.

+20
+30
+10
+16
+18
+12
+14
+8
+6
+4
+2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
+15
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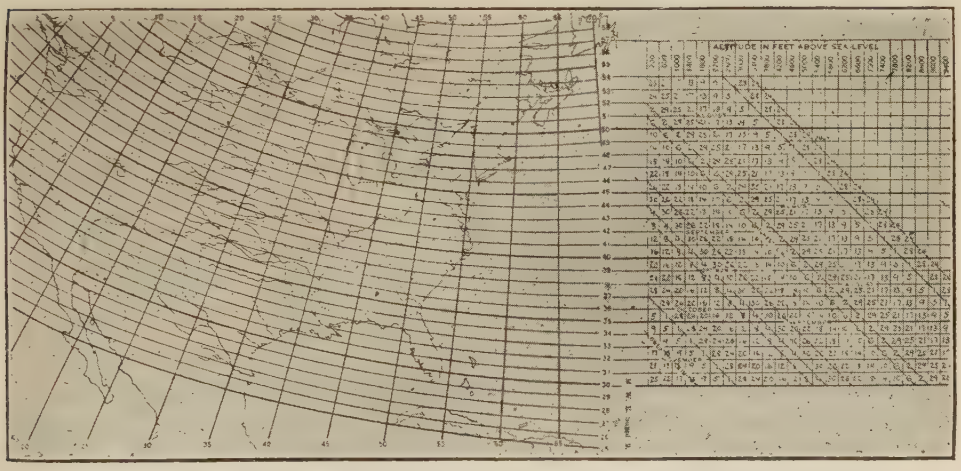
+225
+230

It will be observed that some of the departures (in days) are plus (later) and others are minus (earlier) than the computed average date. "In general, for the whole country, the departures for spring and early summer events are plus the constant for valleys and coasts, and minus for plains, plateaus and mountains; and the reverse for late summer and autumn events." (Figs.)

It is, of course, impossible at present to indicate the extent which this Law can be used in furthering investigations of insect and fungous diseases. Hopkins has shown that the Law has been of service in the control of the Hessian Fly and certain forest insects, consequently it is quite natural to suppose that other insects may also be controlled to better advantage by making use of this Law. It seems to me that if ever the method of Natural Control, discussed in my previous address, is to be employed on a wide scale, it must be based firmly on the Bioclimatic Law.



An Isophanal Map of the United States with annexed Chart to show best dates for fall wheat seeding in different districts.

Hopkins also suggests that the Law may be of service in the investigation and control of fungous diseases. The appearance of the earliest spring stages of many fungi, those largely concerned in the inoculation of plants, are dependent on climatic factors which, as we have seen, influence the time of leafing and flowering of plants.

Our spraying calendars are now based on phenological phenomena: this fact is but another evidence of the importance of relating farm and orchard operations to the Bioclimatic Law.

CAN WE IMPROVE POTATO STORAGE METHODS ?

P. I. Bryce, Macdonald College.

The potato stands next only to wheat as the source of the vegetable food in our diet. While the potato contains a high percentage of water, its flavor, its

simple culture, its abundant yield, and the apparent ease of caring for the harvest, place it high amongst our staple foods.

With the present soaring prices of food, it is an impressive fact that potatoes give a greater yield in weight per acre than any other food crop. Quebec had an area of 13,292,798 acres under cultivation in 1918, and of this 264,871 acres were planted to potatoes. The yield per acre was 147 bushels, the total yield 38,936,000 bushels, valued at $38,157,000.

Though in Canada, potatoes are mainly cooked fresh, a good quantity is boiled, shredded and dried, mainly for camp use. In the United States, the tubers find use as commercial potato starch, flour, and for making glucose, syrup, mucilage and sizing for paper. As a basis of industrial alcohol, the potato is largely used in Europe, and the smaller tubers form an important stock food. Quebec is likely to become more and more a source of seed potatoes, for which the climate is highly suited.

Canada has increased her yield from 75,300,000 bushels annually for the period 1909-1913, to 104,346,000 bushels, 1918, and 125,575,000 bushels in 1919. The United States have fallen back from a production of 411,860,000 bushels in 1918 to 357,901,000 bushels in 1919, and an increased market, it is seen, is opening for the Quebec producer.

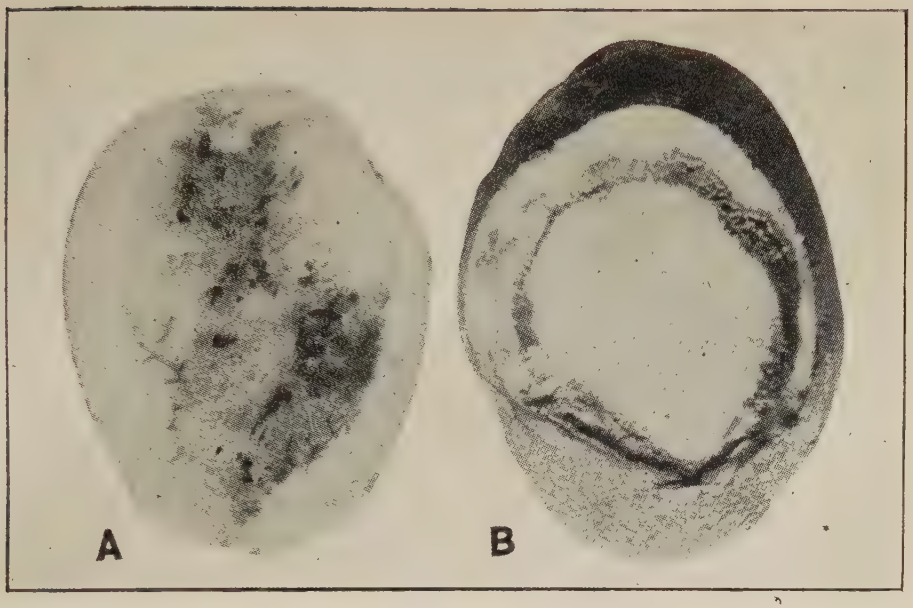
There is, then, a great and notable source of wealth in the potato, and the importance of conserving the annual harvest by proper storage methods, till it can be transported to its market, must be apparent.

We have heard and seen recently, indeed, that large as was the potato harvest in 1919, the amount of it available six months later, is far short of the demand. Potatoes sell at $6.50 a bag or more, and at that figure, the supply is scarcely equal to the demand.

Much of this shortage is due, we believe, to shrinkage in storage where frost, decay and wilt have diminished the supply. Not less than 8-10% of the Canadian crop has thus been lost, a drop since harvest of 1,225,750 bushels. The estimated loss in the U.S.A. is 8% or not less than 13,047,968 bushels.

Diseases of Stored Potatoes.

While many diseases attack the potato in storage, particularly destructive are the parasitic fungous diseases, late blight and rot (Phytophthora infestans de Bary), dry rot (Fusarium sp.), the parasitic bacterial diseases, common scab (Actinomyces chromogenus Gasp.), and wet rots (Bacillus solanisaprus Harrison) and others. Other storage defects or maladies are classed as non-parasitic including frost necrosis or injury, black heart, and internal brown streak.



DRIED OUT NECROTIC LESIONS—Tubers found in storage in March which appeared perfectly sound externally. A—Net type of frost necrosis in which pitting has resulted from drying out. B—Ring type, very opaque discoloration, also pitted. (After L. R. Jones, M. Miller and E. Bailey, Frost Necrosis of Potato Tubers, Research Bull. 46, Agr. Exp. Sta. of the Univ. of Wisconsin).

Fusarium Dry Rot of Stored Potatoes. (After C. A. Zavitz, Potatoes, Bul. 239, Ont. Agr. College).

Characteristics of Diseases.

Late blight rot or potato disease is notorious as the cause of the potato famine of 1845 in Ireland. It is quite prevalent in moist autumns in Eastern Canada when it attacks the leaves and stems, thence invading the tubers. In the stored, infected potatoes, dry rot is the form taken by the disease. The skin exhibits darker brown, slightly shrunken areas, more than normally hard. Cut across, the flesh appears mottled with brown which spreads around the margin, gradually involving the whole tuber in decay. Soft rots may accompany dry rot. It must be remembered that infected seed potatoes carry the fungus with them to the field, to there reinfect the new crop, should the seed grow. Estimated losses from late blight and dry rot are, United States, $36,000,000 annually; New York, $10,-000,000 for 1912; for Prince Edward Island, $1,000,000 in 1915, when the disease was more than usually severe, and the damage done was on the same or a larger scale over Eastern Canada.

Fusarium Wilt and Dry Rot.

This "imperfect" fungus (Fusarium sp.) causes the trouble known as dry rot, end rot and bundle blighting. Infected seed gives seemingly normal plants which, however, wilt about blossoming time, and the vascular bundles of the stem are discolored. The roots are affected, and the young tubers often attacked at the stem end, with stem end rot. The fungus can rot potatoes under dry conditions but grows faster if it enters through wounds. It causes little injury at 32° to 36° F. The dry rot is a brown, compact, firm rot, without a foul odor. Cavities are often present, in which mycelium grows plentifully. Careful handling in digging, and storing is advised to avoid cuts and bruises. Clean and very cool storage reduces danger of diseases.

Wet or Soft Rots.

These decays are caused by bacteria, by a Sclerotinia fungus, and by black or blue molds, but potatoes are rarely attacked, except as a secondary infection. Taubenhaus describes a black rot or jelly end rot as caused by Fusarium radicicola Woll, "The stem end soft rots. The disease progresses inwards until the entire tuber within the skin becomes soft and jelly-like in consistency. The trouble is confined mostly to Idaho, Rural, and Pearl (varieties)."

Soft Rot and Black Leg.

Bacillus solanisaprus (Harrison) causes a drooping and shrivelling of leaves and stem, with black areas on petioles and stems near the ground. On tubers, "the skin shows reddish-brown discolored areas, something like a bruise, with a firm consistency," the flesh beneath turns soft. A black line marks off the healthy and diseased areas. "In the final stage the potato becomes a mass of black soft pulp". In storage, the rot spreads. Seed potatoes carry over the disease, and the

young plants become infected. Seed with brown discoloration should not be planted.

Black Heart.

In this non-parasitic disease there is discoloration of the central part of the tuber. Though it has been blamed upon overheating, experiments indicate the cause is lack of oxygen, as in potatoes stored in large piles. It is essentially a disease from imperfect ventilation.

Frost Necrosis.

The freezing point of the potato tuber is somewhat lower than 32°F., but below 30.7° F., 50-75% of potatoes tested froze. The resulting frost necrosis apears as a blackening of the water conducting tissue and is known as net, ring, or blotch necrosis. As setts, frost-injured seed gave only about 50% of a stand of normal production. Such injured seed thus must be planted twice as thickly, but badly frozen potatoes should not be used for seed. Rotten pieces must be rejected.

Suggestions on How to Store Potatoes.

Proved factors in good potato storage are control of temperature, of light, of air movement, and of humidity.

The temperature should be kept at 36°-40° F. All daylight should be excluded from storage places, but subdued light does not cause greening of potatoes.

Humidity may be kept fairly high at the low temperature. It prevents excessive loss in weight by drying. The percentage humidity must not be so high that moisture condenses on the potatoes.

Why ventilation ? Beucause pure fresh air kept in circulation maintains even conditions of moisture and heat, and a sufficient supply of oxygen. It is very difficult to control in pit or cellar storage. Air movement should be permitted as long as temperature is above danger point. An ordinary thermometer is a necessity in the storage place, to prevent risk of black heart and sweating.

Treatment before storage is not generally practised. It has been shown by Zavitz, however, that dusting sound potatoes and slightly decayed potatoes with hydrated lime reduced decay in stored potatoes to 0.8 per cent. for sound, and 40 per cent. for slightly decayed as compared to 4.5 per cent. of decay for sound untreated, and 58.3 per cent. of decay in slightly decayed. The length of storage was from November 7, 1912 to June 7, 1913, and November 23, 1915 to February 23, 1916. Twelve tests were made, and 5,000 tubers used, of three varieties. Treatment, then, appears profitable in years when rot in severe as in 1912 and 1915.

Temporary Storage.

It is sometimes necessary to store potatoes temporarily in the field. The potatoes should be placed in piles in a dry part of the field, covered with straw, with a little earth thrown over it. Add more straw and earth in cold weather.

Cellar Storage.

Potatoes should be dug as soon as the tops have died, and as far as possible before there is danger of much soil freezing. They should be dried for a day in the open air, and stored away in boxes, crates, barrels or small bins in the cellar. Room for air circulation must be given, allowing not less than 4 inches space between bins. Storage should be arranged for in the coolest and best ventilated room of the cellar. It is essential that it be possible to exclude cold air in mid-winter so that no danger of frosting be incurred. A room on the north side permits exclusion of the sunlight. Ventilation can be carried on in the fall by means of a window; and a slide in a double window on the outside during the winter. It is better to use a ventilating chute or air duct carrying cool fresh air to the floor. Put a damper in the air duct. A hinged or slide door in the sash can be used as outlet for warm air. The window must be darkened somewhat to prevent growth. Most roots can be safely stored in the same room and help to maintain suitable moisture conditions.

Commercial Storage.

With greater quantities of potatoes to be stored more definite provision for aeration and protection is required. Various types of storage are used such as dug-out pits or root-houses, insulated frame structures, and cold storage houses. Where potatoes are the main crop as in Aroostock Co., Me., and in parts of New Brunswick, large houses with a drive down the middle and bins on each side are used.

For the farmer, the dug-out pit or root-house is of ample size and can be adopted to conditions admirably. The full length of the store house may often be dug in the side of a hill or the slope near the barn. It should be placed in as dry and convenient a situation as possible. Make the excavation the size of the cellar, using the soil taken out for covering the roof and banking the sides. Set two rows of posts of uniform height in the bottom of the pit near the dirt walls, and a third line of posts about five feet higher along the centre of the pit. On these posts is supported the planks forming the roof. Make double doors at one end, and put a ventilator in the roof. On the roof, place sod, then soil, and add a layer of strawy manure, one to four feet thick to keep out frost.

The potatoes are placed best in aerated crates or bins with ventilated partitions, on a false floor two or four inches above the dirt, board, or cement floor.

The false floor of the bins is made of 7-8 x 4 inch slats laid one inch apart, on 2 x 4 inch sills. Division walls should be of 2 x 4 inch uprights on the 2 inch side of which are nailed 7-8 x 4 inch strips, leaving a one inch space for ventilation. Bins should thus have a 4 inch space separating them. For the front of the bin movable 7-8 x 4 inch strips fitting in grooves attached to the uprights are used. The strips may be put in gradually as the bin is filled. Such a bin gives ventilation, ease in getting potatoes out, while cleaning each summer is easily done. This bin has proved a success at Macdonald College, and is in use by the U. S. A. Dept. of Agriculture.

Bearing in mind some of the points suggested we find that the potato ranks next to wheat as a food. Quebec produced 38,936,000 bushels worth $38,157,000 in 1918. At the Central Experimental Farm, Ottawa, potatoes have been produced on a small plot at the rate of 722 bushels per acre.

The annual loss through shrinkage, frost, decay, and wilt in storage is believed to be 8 to 10% of the annual crop.

Improperly stored, or diseased potatoes are subject to a member of preventible diseases. These are in general parasitic fungous and bacterial diseases, and non-parasitic troubles. Diseased, bruised, frosted, tubers should not be stored with sound potatoes.

Diseased potatoes may be sprinkled with hydrated lime, and if carefully stored rot is less than with untreated potatoes. Potatoes should be picked over and the diseased removed from time to time. Diseased seed should not be used. It is partly worthless and spreads the trouble in the field. Unsound tubers should not be sold unless marked plainly.

Important factors in good storage are a temperature of 36-40° F., exclusion of sunlight, good ventilation, but protection from frost, and fairly moist conditions.

Potatoes temporarily stored in the fields should be carefully protected from frost and rain.

In cellar storage, the use of small rather than large containers or heaps is advisable.

For the commercial grower, the dug-out or partly underground storage may well be used. A frost proof house is an essential, and this requires insulated walls. The insulation may consist of strawy manure outside. Ventilation is necessary in fall and spring. Easily ventilated crates or bins are better than storage on the floor, to avoid dampness, and black heart.

Finally, careful shipping pays. Pack well and avoid rough handling. Bruising and shaking in transit should be prevented. Ship in clean, tight cars which must be warmed in winter.

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